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QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

改版履歴

版数	日付	改版内容
1.0	2026/02	初版発行
1.1	2026/10	・07-システム管理の 2 章 NTP に 2.9 章を追加しました。 ・07-システム管理に 7 章 NQA の説明を追加しました。 ・07-システム管理の 6 章 NetMeister の文中の図の番号間違いを修正しました。 ・08-高可用性を追加しました。それに伴い謝辞を 08 から 09 へ番号を変更しました。 ・08-高可用性に 1 章 Track を追加しました。

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本マニュアルについて

バージョン

本マニュアルに対応する製品バージョンは Version 1.0.X 以降のソフトウェアです。

関連マニュアル

次のマニュアルには、QX-S900M シリーズ Ethernet スイッチに関する詳細な説明があります。

マニュアル	内容
QX-S900M シリーズ Ethernet PoE スイッチ インスタレーションマニュアル	システムのインストールについて説明しています。
QX-S900M シリーズ Ethernet PoE スイッチ オペレーションマニュアル	機能の設定について説明しています。
QX-S900M シリーズ Ethernet PoE スイッチ コマンドマニュアル	機能に関するコマンドについて説明しています。
QX-S900M シリーズ Ethernet PoE スイッチ Web コンソール操作マニュアル	Web コンソールからの装置設定、状態確認等についての操作を記述しています。

マニュアルの構成

このコマンドマニュアルは以下のセクションで構成されます。

- **はじめに**

  Ethernet スイッチへのアクセス方法、ファイルシステム管理、設定ファイル管理、ソフトウェア管理、装置管理といった、Ethernet スイッチの管理の設定について説明します。

- **アクセス**

  Ethernet ポート、リンクアグリゲーション、VLAN といった、レイヤ 2 機能の設定について説明します。

- **IP サービス**

  ARP、IP アドレス、DHCP といった、ネットワークプロトコルの設定について説明します。

- **IP ルーティング**

  ルーティングプロトコルの設定について説明します。

- **ACL and QoS**

ACL の設定について説明します。

- **セキュリティ**

  AAA、アクセス管理、SSH 等の設定について説明します。

- **システム管理**

  システム保守、ネットワーク管理の設定といった、Ethernet スイッチのシステム管理および保守について説明します。

- 高可用性

  Track の設定について説明します。

表記規則

本マニュアルでは、次の表記規則を使用しています。

I. コマンド表記規則

表記規則	説明
太字体	コマンドラインを示すキーワードには**太字体**を使用します。
イタリック体	コマンドの引数は*イタリック体*を使用します。
[ ]	大カッコに囲まれた項目(キーワード、引数)はオプションです。
{ x | y | … }	選択する項目は、中カッコに入れて縦線で区切ってあります。1 つを選択します。
[x | y | …]	オプションの選択項目は、大カッコに入れて縦線で区切ってあります。1 つまたは複数を選択します。
{ x | y | … }*	選択する項目は、中カッコに入れて縦線で区切ってあります。少なくとも 1 つ選択できます。
[x | y | …]*	オプションの選択項目は、大カッコに入れて、縦線で区切ってあります。1 つあるいは複数選択することも、何も選択しないこともできます。
&<1-n>	&の前のキーワードと引数を組み合わせます。引数で指定した数までキーワードを繰り返し指定できます。
#	#で始まる行はコメントを示します。

II. GUI 表記規則

表記規則	説明
< >	ボタン名は三角カッコに入っています。たとえば、<OK>ボタンをクリックします。
[ ]	ウィンドウ名、メニュー項目、データ表、およびフィールド名は大カッコに入っています。たとえば、[New User]ウィンドウが表示されます。

表記規則	説明
/	複数レベルのメニューはスラッシュで区切ってあります。たとえば、[File/Create/Folder]。

III. キーボード操作

表記規則	説明
<KEY>	KEY のキーを押します。たとえば、 <Enter>は Enter キーを押します。
<KEY1 + KEY2>	複数のキーを同時に押します。たとえば、 <Ctrl+Alt+A>は 3 つのキーを同時に押すことを表します。
<KEY1, KEY2>	複数のキーを順番に押します。たとえば、 <Alt, A>は 2 つのキーを順に押すことを表します。

IV. マウス操作

表記規則	説明
クリック	マウスのボタンを素早く押します。特に指定がない場合は左ボタンを押します。
ダブルクリック	マウスの左ボタンを素早く 2 回押します。
ドラッグ	マウスの左ボタンを押したまま移動します。

V. 記号

表記規則	説明
⚠ **警告**	表示を無視したり指示に従わない場合、利用者が怪我などをする恐れのある重要な情報を示します。
⚠ **注意**	表示を無視したり指示に従わない場合、データの損失や破損、ハードウェアやソフトウェアの損傷などが発生する恐れのある重要な情報を示します。
⚠ **重要**	注意を払う必要がある情報を示します。
🕮 **メモ**	追加または補足となる情報を示します。
🕮 **ポイント**	参考となる情報を示します。

VI. ネットワークアイコン

表記規則	説明
	ルータ、スイッチ、またはファイアウォールなどの一般的なネットワークデバイスを表しています。
	ルータまたはレイヤ 3 スイッチなどのルーティング対応のデバイスを表しています。
	レイヤ 2、レイヤ 3 スイッチまたはレイヤ 2 転送機能に対応したルータなどの一般的なスイッチデバイスを表しています。

VII. 設定例

本マニュアルの設定例は各機能での代表的な設定例を示します。インタフェース番号、システム名の表記、display コマンドで表示される情報は、ご使用の装置と異なることがあります。

VIII. セキュリティ強化

セキュリティ強化のため、simple で設定されたパスワードも cipher や hash で登録されます。

本マニュアルは以下に示す７個のセクションで構成されています。

01 - はじめに

02 - アクセス

03 - IP サービス

04 - IP ルーティング

05 - ACL and QoS

06 - セキュリティ

07 - システム管理

09 - 謝辞

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

1. はじめに

本マニュアルは以下に示す章で構成されています。

01-CLI
02-ログイン
03-コンソールポートによる最初のログイン
04-CLI によるログイン
05-SNMP によるアクセス
06-ログインユーザの制御
07-ファイルシステム管理
08-コンフィグレーションファイル管理
09-ソフトウェアのアップグレード
10-装置管理
11-Auto Config

目次

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1章 CLI

Command-Line Interface （CLI）は、装置とユーザ間の相互運用ユーザインタフェースです。装置の設定、管理、モニタリングを行うため、CLI からコマンドを入力します。

```
<Switch> system-view
[Switch]
```

CLI にはコンソールポートを使用する以外にも、Telnet、SSH などを使用してログインすることができます。

1.1. CLI viewの記述

コマンドは機能によって異なる view にグループ分けされています。コマンドを使用する場合、その view に入る必要があります。

CLI view は図 1-1 に示すような階層構造となっています。各 view は、どこで何を行うのかを一意に示すプロンプトとなります。たとえば[Switch-vlan100]という view は、VLAN100 view で、その VLAN の属性を設定することができます。

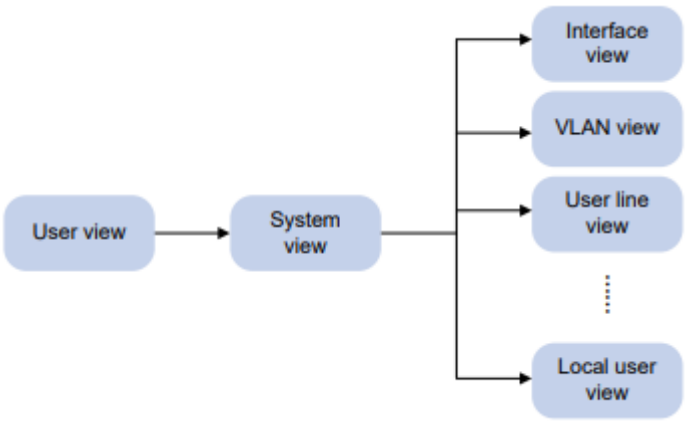

図 1-1 CLI view

CLI でログインした後、最初に user view に入ります。user view のプロンプトは<Device-name>で、Device-name は装置名を示します。デフォルトは装置名で、sysname コマンドを使用して変更することができます。

user view では以下の操作を行うことができます。

- 表示、デバッグ、ファイル管理、FTP、Telnet、日時の設定、再起動などの基本的な操作を行うことができます。
- user view から system view に移行することができます。system view のプロンプトは[Device-name]です。

system view では以下の操作を行うことができます。

- サマータイム、バナー、ホットキーなど、装置全体に影響する設定を行うことができます。
- system view からさらに、異なる view に移行することができます。たとえば、以下の操作を行うことができます。

- interface view に移行し、インタフェースパラメータの設定ができます。
- VLAN view に移行し、VLAN にポートを追加することができます。
- user line view に移行し、ログインユーザの属性を設定することができます。
- IRF physical interface view に移行し、IRF パラメータの設定ができます。

view プロンプトでクエスチョン “?” を入力することで、その view で利用できるすべてのコマンドを表示します。

1.1.1. user view から system view への移行

操作	コマンド
system viewに移行する	**system-view**

1.1.2. 各 view から上位 view への戻り

操作	コマンド
各viewから上位viewに戻る	**quit**

user view で **quit** コマンドを実行することで、装置の接続を終了します。

1.1.3. user view への戻り

return コマンドあるいはホットキー**Ctrl+Z** を実行することで直接 user view に戻ることができます。

操作	コマンド
user viewに戻る	**return**

1.2. コマンドラインを使ったオンラインヘルプ

CLI オンラインヘルプは状況に応じてヘルプ情報が異なります。すべてのプロンプトで“?”を入力し、その view で利用できるコマンドを表示するか、コマンドのいずれかの位置で、すべての有効なオプションを表示することができます。

CLI オンラインヘルプにアクセスするには以下の方法を行います。

- 各 view で “?” を入力することで、その view で利用できるすべてのコマンドの最初のキーワードを表示します。

```
<Switch> ?
 cd Change current directory
 clock Manage the system clock
 configure Enter configuration mode
 copy Copy from one file to another
 crypto Encryption module
 debug Debug configuration
 delete Delete a file
 dir List files on a file system
 display Show running system information
 dot1x 802.1X global configuration commands
```

```
 free Release a connection
 help Description of the interactive help system
 ip Global IP configuration subcommands
 logout Logout device
 md5sum List files on a file system
 mkdir Create new directory
 more Display the content of a file
 netmeister NetMeister module
 ping Send echo messages
 quit Exit from Exec mode
 reboot Halt and perform a warm restart
 rename Rename a file
 renew Renew a resource
 reset Reset functions
 rmdir Remove existing directory
 save Save current configuration
 ssh Used to log into a remote machine by SSH protocol version 2
 super Switch to a user role
 system-view Enter configuration mode
 telnet Open a telnet connection
 terminal Set terminal parameters
 test test cable diagnostics
 traceroute Trace route to destination
 undo Negate a command or set its resets
<Switch>
```

- コマンドキーワードの後ろにスペースを空けて”?”を入力することで、設定可能なキーワードかパラメータが表示されます。
  - キーワードの場所にスペースを空けて”?”を入力したとき、設定可能なキーワードの概要が表示されます。

```
<Switch> terminal ?
 length Set number of lines on a screen
 width Set number of columns on a screen
<Switch> terminal
```

  - パラメータの場所にスペースを空けて”?”を入力したとき、設定可能なパラメータの概要が表示されます。

```
<Switch> system-view
[Switch] interface vlan-interface ?
 INTEGER<1-4094> <VLAN id>
[Switch] interface vlan-interface 1 ?
 <cr>
[Switch] interface vlan-interface 1
```

<1-4094>は引数の値の範囲で、**<cr>**はコマンドを示します。完了させるには、**Enter** キーを押してコマンドを実行することができます。

1.3. コマンドのundo

ほとんどの設定コマンドに、undo を付加できます。以下のことができます。

- 設定を取り消すときに使用します。

- システムをデフォルトの状態に戻します。
- 機能を無効にします。

たとえば、Information Center を有効にするために、**info-center on** コマンドを使用した場合、**undo info-center on** コマンドで Information Center を無効にします。

1.4. コマンドの実行

コマンドを入力することで、以下のことができます。

- キーあるいはホットキーを使用してコマンドラインを編集できます。
- 省略したキーワードあるいはエイリアスを使用することができます。

1.4.1. コマンドラインの編集

コマンドラインを編集するために、表 1-1 に示すキーを使用することができます。終了するには **Enter** キーを押してコマンドを実行します。

表 1-1 コマンドラインの編集キー

キー	機能
コマンドキー	編集バッファが一杯でなければ、カーソル位置に文字を挿入し、カーソルを右に移動します。コマンドの最大の長さは、511文字です。バッファが一杯でない限り、**Enter**キーを押す前に入力したすべてのコマンドは編集バッファに保存されます。
Backspace	カーソルの左側の文字を削除し、1文字分カーソルを戻します。
左矢印キー （←）	カーソルが左に1文字分移動します。
右矢印キー （→）	カーソルが右に1文字分移動します。
上矢印キー （↑）	前に入力した履歴バッファを表示します。
下矢印キー （↓）	次に入力した履歴バッファを表示します。
Tab	キーワードの一部でTABキーを押した場合、システムは自動的にキーワードを補完します。 • ただ 1 つマッチングしたら、システムは不完全なキーワードを完全なキーワードに置き換えて、それを次の行に表示します。。 • マッチするものが複数ある場合、キーワードを選択するため TAB キーを複数回押してください。 • マッチするものが全くない場合は、システムは不完全なキーワードを補完せず、再度それを次の行に表示します。

コマンドラインの最大長は 512 文字を超過することができません。512 文字にはスペース、特殊文字が含まれます。

- **#** ― システムによって隣接セクションと区別するためにコンフィグレーションファイルの中で使用します。
- **version** ― ソフトウェアバージョンを示すため、コンフィグレーションファイルの中で使用します。たとえば **version 7.1. xxx** です。

これらのコマンドは以下の理由があるため特殊文字となります。

- CLI でユーザが使用することはできません。
- すべての view で特殊文字を入力する、あるいはすべての値入力することができます。たとえば、**# abc** あるいは **version abc** を入力することができます。しかし、設定は適用されません。
- 装置はこれらの特殊文字に関するオンラインヘルプはありません。

1.4.2. 引数の文字列あるいはテキストタイプ値の入力

テキストタイプの引数はクエスチョンマーク（?）を除く印刷可能な文字列を使用することができます。

文字列タイプの引数は以下の文字列を除く印刷可能な文字列を使用することができます。

- クエスチョンマーク (?)
- クオーテーションマーク（"）
- バックスラッシュ (\)
- スペース

特定の引数が必要となる場合があります。

印刷可能な文字列は、文字あるいは ASCII コード（範囲は 32～126 です）を入力することができます。

1.4.3. コマンドの補完

コマンドは、キーワードの一部を入力することでコマンドを実行できます。ただし、入力するコマンドを識別するのに十分な文字列を入力した場合のみ有効です。たとえば、user view では、**s** で始まるコマンドには **startup saved-configuration** や **system-view** があります。**system-view** を指定する場合、最低でも **sy** を入力する必要があります。**startup saved-configuration** を指定する場合、最低でも **st s** を入力する必要があります。

Tab キーを押すことで、完全なコマンドを表示、入力することができます。

1.5. 履歴コマンドの保存

システムは、ログインユーザによって実行されたコマンドを自動的に保存します。保存されたコマンドを表示するには **display history** コマンドを使用してください。

保存されたコマンドは、以下のキー操作でも呼び出すことができます。

- **CTRL+P または 上矢印キー(↑)**: 履歴バッファ内のコマンドを、最新のコマンドから順に呼び出します。キー操作を繰り返すことで、さらに古いコマンドが順次呼び出されます。
- **Ctrl+N または 下矢印キー(↓)**: Ctrl+P または 上矢印キー(↑)で呼び出したコマンドの後、より新しいコマンドに戻ります。キー操作を繰り返すと、順次新しいコマンドが呼び出されます。

履歴バッファのサイズは 20 コマンドに固定されています。

1.5.1. 履歴コマンドのルール

履歴コマンドを使用したときのルールを示します。

- コマンド入力時に不完全なキーワードを使用した場合、システムはその入力したままの形式でコマンドをバッファリングします。

- コマンド入力時にエイリアスを使用した場合、システムはバッファリング前にエイリアスを、それが表すコマンドまたはコマンドキーワードに変換します。
- 同一フォーマットのコマンドを連続して複数入力した場合、履歴コマンドには 1 回のみ履歴に保存します。異なるフォーマットのコマンドを連続して複数入力された場合、各コマンドが履歴に保存されます。たとえば display cu コマンドと display current-configuration コマンドの 2 つのエントリが連続して入力された場合、display cu コマンドと display current-configuration コマンドが履歴に保存されますが、display cu コマンドが繰り返し入力された場合、display cu コマンドが 1 回のみ履歴に保存されます。
- バッファが一杯の状態では、新しいコマンドを保存するため、最も古いコマンドの履 歴が削除されます。

1.6. CLI表示の管理

この項では、必要な出力を特定するのに役立つ CLI 出力制御機能について説明します。

1.6.1. 出力のスクリーンの休止

デフォルトでは、出力が行数 24 行を超えると画面に収まらず、システムは自動的に一時停止します。この制限は **terminal length** *number* コマンドで変更可能です。一時停止時には、システムがこれらのメッセージ：**CTRL+C ESC q Quit SPACE n Next Page ENTER Next Entry a All** を表示します。「I. 出力制御キー」で説明されているキーを使用して、追加情報の表示や表示の停止が可能です。

現在のセッションでは、出力画面間の表示停止を無効にすることもできます。この場合、すべての出力が一度に表示され、最終画面が表示されるまで画面が継続的に更新されます。

I. 出力管理キー

キー	機能
Space、n	次画面ページの情報を示し続けます
Enter	次のラインの情報を示し続けます。
Ctrl+C、ESC、q	表示とコマンド実行を中止します。
<PageUp>	前のページを表示します。
<PageDown>	次のページを表示します。

II. スクリーン出力機能の無効化

スクリーン出力機能を無効にするには、user view で以下のコマンドを実行します。

操作	コマンド	補足
現在のセッションで複数のスクリーン出力機能を無効にする	**terminal length 0**	デフォルト：24行

1.7. 稼働中の設定の保存

すべての view で、**save** コマンドを使用して、実行されたコマンドを設定ファイルに保存することができます。設定ファイルに保存されたコマンドは、再起動して復活させることができます。**save**

コマンドは、指定された情報を表示する **display** コマンドや指定された情報をクリアする **reset** コマンドのような 1 回限りのコマンドには適用されません。

目次

このセクションのページは **1-x-x** です。

2章 ログイン 2-1

2章　ログイン

初回の装置へのログインは、コンソールポートを使用した CLI ログインのみ行うことができます。2 回目以降はコンソールログインパラメータやコンソール、Telnet、SSH、SNMP を含む他のアクセス方法を変更することができます。

表 2-1 ログイン方法の概要

ログイン方法		デフォルト設定、必要最低限の設定
CLI のログイン	ローカルコンソールログイン	デフォルトでは、コンソールポートのログインは有効、認証は不要です。デフォルトのユーザロールは**admin**です。ログイン後は、装置のセキュリティ確保のため、AUXラインのパスワード認証または認証スキームモードを設定してください。
	Telnet 接続によるログイン	デフォルトでは、Telnet 接続による ログインは無効です。 Telnet 接続による ログインを行うため、以下の設定が必要です。 • Telnet サーバ機能を有効にします。 • レイヤ 3 インタフェースに IP アドレスを設定し、インタフェースと Telnet クライアント間で通信可能なことを確認します。 • VTY ログインユーザ用に認証モードを設定します。デフォルトではパスワード認証が使用されますが、パスワードは設定されていません。 • VTY ログインユーザにユーザロールを割り当てます。デフォルトでは、VTY ログインユーザにはオペレータユーザロールが割り当てられます。
	SSH 接続によるログイン	デフォルトでは、SSH 接続によるログインは無効です。 SSH 接続によるログインを行うため、以下の設定が必要です。 • SSH サーバ機能を有効にし、SSH 属性を設定します。 • レイヤ 3 インタフェースに IP アドレスを設定し、インタフェースと SSH クライアント間で通信可能なことを確認します。 • VTY ログインユーザ用に認証モードを設定します。デフォルトではパスワード認証が使用されます。 • VTY ログインユーザにユーザロールを割り当てます。デフォルトでは、VTY ログインユーザにはオペレータユーザロールが割り当てられます。
SNMPからのアクセス		デフォルトでは、SNMPによるアクセスは無効です。 SNMPによるアクセスを行うため、以下の設定が必要です。 • レイヤ 3 インタフェースに IP アドレスを設定します。インタフェースと NMS 間で通信可能なことを確認します。SNMP 基本パラメータを設定します。

メモ:

これらのログイン方法のアクセス制御リスト（ACL）は、いずれの ACL ルールにも一致しないパケットを拒否します。

目次

このセクションのページは **1-x-x** です。

3 章 コンソールポートによる最初のログイン 3-1

3章　コンソールポートによる最初のログイン

初回の装置へのログインは、コンソールポートを使用した CLI ログインのみ行うことができます。

コンソールポートから装置にログインするには、PC などのコンソール端末を準備します。コンソール端末に HyperTerminal や PuTTY などの端末エミュレーションプログラムがインストールされていることを確認してください。端末エミュレーションプログラムの使用方法については、各プログラムのユーザガイドを参照してください。

コンソールポートでログインする場合は以下の手順に従ってください。

1. PC のシリアルポートに D-sub9 ピンメスコネクタを接続します。
2. 装置のコンソールポートを確認し、装置のコンソールポートにコンソールケーブルの RJ-45 コネクタを接続します。

⚠ 重要　：

- コンソールポートのマークを確認し、正しいポートに接続していることを必ず確認してください。
- PC のシリアルポートはホットスワップ機能にサポートしていません。装置に接続する前に PC にコンソールケーブルを最初に接続してください。ケーブルを取り外すときは、最初に装置から取り外してください。

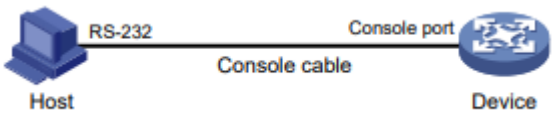

図 3-1 コンソールポートとの接続

3. PC が電源 OFF である場合、PC の電源を ON にしてください。
4. PC で端末エミュレーションプログラムを起動し、装置に接続する端末の設定を行います。ポートのプロパティを以下のコンソールポートのデフォルト設定に一致するように設定します。
   - **通信速度** – 9600 bps
   - **フローコントロール** – なし
   - **パリティ** – なし
   - **ストップビット** – 1
   - **データビット** – 8
5. 装置の電源を入れ、プロンプトが表示されたら **Enter** キーを押下します。

ユーザアクセス認証が必要です。デフォルトのパスワード *qx_admin* を入力してください。デフォルトの user view プロンプトが表示されます。装置の設定や管理を行うコマンドを入力できます。ヘルプ画面を表示する場合、クエスチョンマーク（?）を入力します。

目次

このセクションのページは **1-x-x** です。

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4章 CLI によるログイン

初回の装置へのログインは、コンソールポートを使用した CLI ログインのみ行うことができます。装置の管理を容易にするため、コンソールポートや Telnet、SSH を含む他のアクセスでログインすることができます。

CLI への不正アクセスを防止し、ユーザロールを管理するため、以下のことを行うことができます。

- ログイン認証の設定
- ユーザロールの割り当て
- 無許可ログインのフィルタリングを行う ACL

本章では、ログイン認証、ユーザロール、共通ユーザライン設定を含む、CLI ログイン方法の設定と使用方法について説明します。

4.1. CLI概要

I. ユーザライン

装置は CLI セッションを管理し、ユーザのふるまいをモニタリングするため、ユーザライン（ユーザインタフェースと呼ばれます）を使用します。ユーザラインでのログイン認証、ユーザロールを含むアクセス管理の設定を行うことができます。

ユーザは表 4-1 のようにログイン方法に依存した異なるユーザラインに割り当てられます。

表 4-1 CLI ログイン方法とユーザライン

ユーザライン	ログイン方法
AUXユーザライン	コンソールポート
Virtual type terminal (VTY) ライン	Telnet あるいは SSH

II. ユーザラインの割り当て

装置は、表 4-1 に示すように、ログイン方法に応じて CLI ログインユーザにユーザラインを割り当てます。CLI ログインで、装置は、ログインタイプ用に、有効で空いているユーザラインから最も低い値を用います。たとえば、4 つの VTY ライン（0～3）が設定されており、そのうち VTY0 と VTY3 がアイドル状態の場合、ユーザが装置に Telnet 接続すると、装置は VTY0 を割り当てます。

各ユーザラインは 1 度に 1 つのユーザにのみユーザラインを割り当てることができます。ユーザラインが有効でない場合、CLI ログインは拒否されます。

4.1.1. ログイン認証モード

装置の CLI への不正アクセスを防ぐため、ログイン認証を設定することができます。

装置は以下のログイン認証モードをサポートしています。

- **None** – 認証なし。このモードはセキュリティの保護がありません。
- **Password** – パスワード認証が必要です。ユーザはログイン時に正しいパスワードを入力する必要があります。

- **Scheme**－ローカルログイン認証を行うため、AAA モジュールを使用します。ログイン時にユーザ名、パスワードを使用する必要があります。

異なるログイン認証モードは、表 4-2 のようにユーザラインで異なる設定が必要です。

表 4-2 異なるログイン認証で必要な設定

認証モード	操作
None	認証モードを**none**に設定します。
Password	1. 認証モードを **password** に設定します。 2. パスワードを設定します。
Scheme	1. 認証モードを **scheme** に設定します。

4.1.2. ユーザロール

ユーザはログインするときユーザロールが割り当てられます。ユーザロールは、ユーザが実行できるコマンドを指定します。装置は、ログイン認証モードとユーザタイプに基づいてユーザロールを割り当てます。

- **None** あるいは **password** 認証モードが使用される場合、装置はユーザラインで指定されたユーザロールを割り当てます。
- **scheme** 認証モードが使用される場合、以下のようにユーザロールを割り当てます。
  - 公開鍵あるいはパスワード公開鍵を使用する SSH ログインユーザの認証において、装置はユーザラインで設定されたユーザロールに従ってユーザロールを割り当てます。
  - その他のユーザにおいて、AAA モジュールで設定されたユーザロールに従ってユーザロールを割り当てます。リモート AAA 認証ユーザにおいて、もし、AAA サーバがユーザにユーザロールを割り当てず、ユーザロール機能が無効である場合、ユーザはログインすることができません。

4.2. コンソールポートでのローカルログイン

図 4-1 のように装置にログインし、管理するため、コンソールポートで端末を接続することができます。

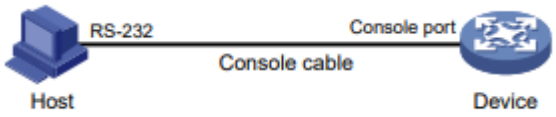

図 4-1 コンソールポートによるログイン

デフォルトでは、コンソールログインはローカルおよびリモートで有効で、認証は不要です。デフォルトのユーザロールは **admin** です。装置のセキュリティの対応を行うため、初回ログインした後に、AUX ラインの password または scheme 認証を設定してください。

コンソールログインを設定するには、以下の作業を実行します。

操作	備考
(必須設定項目)) コンソールログイン用のログイン認証の設定: • None 認証の設定 • password 認証の設定 • scheme 認証の設定	いずれか一つの認証モードが必要です。
(オプション設定項目) AUXユーザラインの共通設定	—

コンソールログインの設定は、ログイン中のユーザには適用しません。設定が行われた後、次にログインするユーザのみ適用されます。

4.2.1. None 認証の設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. AUX line view あるいは class view に移行する	• AUX line view に移行する **line aux** *first-number* [*last-number*] • AUX line class view に移行する **line class aux**	user line viewでの設定は、ユーザラインにのみ適用されます。user line class viewでの設定は、classのすべてのユーザに適用されます。 どちらかの設定がデフォルトから変更された場合、他のviewのデフォルト設定よりも優先されます。user line viewの設定がデフォルトから変更された場合、user line class viewでデフォルトから変更された設定よりも優先されます。 user line class viewの設定は、ログイン中のユーザには適用されません。新規ログインユーザにのみ適用されます。
3. None 認証モードを有効にする	**authentication-mode none**	デフォルト：**password**
4. ユーザロールを割り当てる	**user-role** *role-name*	デフォルト：**admin**

コンソールポートを使用して、次回ログインを行う場合、ユーザ名あるいはパスワードを必要としません。

4.2.2. password 認証の設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—

操作	コマンド	補足
2. AUX line view あるいは class view に移行する	• AUX line view に移行する **line aux** *first-number* [*last-number*] • AUX line class view に移行する **line class aux**	user line viewでの設定は、ユーザラインにのみ適用されます。user line class viewでの設定は、classのすべてのユーザに適用されます。 どちらかの設定がデフォルトから変更された場合、他のviewのデフォルト設定よりも優先されます。user line viewの設定がデフォルトから変更された場合、user line class viewでデフォルトから変更された設定よりも優先されます。 user line class viewの設定は、ログイン中のユーザには適用されません。新規ログインユーザにのみ適用されます。
3. password 認証モードを有効にする	**authentication-mode password**	デフォルト：**password**
4. password を設定する	**set authentication password** { **hash** | **simple** } *password*	デフォルト：設定なし
5. ユーザロールを割り当てる	**user-role** *role-name*	デフォルト：**admin**

コンソールポートを使用して、次回ログインを行う場合、設定したログインパスワードが必要です。

4.2.3. scheme 認証の設定

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. AUX line view あるいは class view に移行する	• AUX line view に移行する **line aux** *first-number* [*last-number*] • AUX line class view に移行する **line class aux**	user line viewでの設定は、ユーザラインにのみ適用されます。user line class viewでの設定は、classのすべてのユーザに適用されます。 どちらかの設定がデフォルトから変更された場合、他のviewのデフォルト設定よりも優先されます。user line viewの設定がデフォルトから変更された場合、user line class viewでデフォルトから変更された設定よりも優先されます。 user line class viewの設定は、ログイン中のユーザには適用されません。新規ログインユーザにのみ適用されます。

操作	コマンド	補足
3. scheme 認証を有効にする	**authentication-mode scheme**	デフォルト：**password**

scheme 認証を使用するには、以下の設定が完了している必要があります。

- リモート認証の場合は、RADIUS scheme を設定します。
- ローカル認証の場合は、ローカルユーザアカウントを作成し、関連する設定を行います。

コンソールポートを使用して、次回ログインを行う場合、設定したユーザ名、パスワードが必要です。

4.2.4. AUX ユーザラインの共通設定

AUX ユーザライン用のいくつかの共通の設定は、設定された後すぐに適用され、現在のセッションを中断してしまうことがあります。AUX ライン設定を変更する前に、コンソールログインとは異なるログイン方法で装置にログインしてください。

設定を変更した後、正常にログインできるように、コンソールターミナルの設定を変更します。

以下に AUX ユーザラインの共通設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. AUX line view または class view に移行する	• AUX line view に移行する **line aux** *first-number* [*last-number*] • AUX line class view に移行する **line class aux**	user line viewでの設定は、ユーザラインにのみ適用されます。user line class viewでの設定は、classのすべてのユーザに適用されます。 どちらかの設定がデフォルトから変更された場合、他のviewのデフォルト設定よりも優先されます。user line viewの設定がデフォルトから変更された場合、user line class viewでデフォルトから変更された設定よりも優先されます。 user line class viewの設定は、ログイン中のユーザには適用されません。新規ログインユーザにのみ適用されます。
3. 通信速度を設定する	**terminal speed** *speed*	デフォルト：9600bps このコマンドはAUX line class viewで設定できません。
4. 画面に表示できる最大行数を設定する	**terminal length** *length*	デフォルト：最大24行 出力の最大行を0とすると画面の表示は停止しません。

操作	コマンド	補足
5. ユーザラインのタイムアウトの時間を設定する	**idle-timeout** *minutes* [*seconds*]	デフォルト： 3分 タイムアウト時間内に、ユーザラインで何も実行されないと自動的にユーザラインの接続が終了します。 タイムアウト機能を無効にする場合、0に設定します。

4.3. Telnetからのログイン

装置のリモート管理を行うため、Telnet サーバを使用することができます。また他の装置を管理するため、装置を Telnet クライアントとして使用することができます。

デフォルトでは Telnet からのログインは無効です。Telnet を設定するには、まず他の方法で装置にログインする必要があります。

4.3.1. 装置の Telnet ログインの設定

操作	備考
(必須設定項目) Telnetからのログイン認証の設定 • None 認証の設定 • password 認証の設定 • scheme 認証の設定	いずれか一つの認証モードが必要です。

Telnet ログイン設定の変更は、現在オンライン中のユーザには適用されません。新規ログインユーザに対してのみ有効になります。

I. None 認証の設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. Telnet サーバを有効化する	**ip telnet server**	デフォルト：無効

操作	コマンド	補足
3. VTY line view または class view に移行する	• VTY line view に移行する **line vty** *first-number* [*last-number*] • VTY line class view に移行する **line class vty**	user line viewでの設定は、ユーザラインにのみ適用されます。user line class viewでの設定は、classのすべてのユーザに適用されます。 どちらかの設定でデフォルトから変更された場合、他のviewのデフォルト設定よりも優先されます。user line viewの設定がデフォルトから変更された場合、user line class viewでデフォルトから変更された場合よりも優先されます。 user line class viewの設定は、ログイン中のユーザには適用されません。新規ログインユーザにのみ適用されます。
4. None 認証モードを有効にする	**authentication-mode none**	デフォルト：password VTY line viewではprotocol inboundコマンドに関連します。 どちらかの設定がデフォルトから変更された場合、VTY line class viewの設定に関係なく、もう一方のコマンドはデフォルト設定を使用します。
5. (オプション設定項目) ユーザロールを割り当てる	**user-role** *role-name*	デフォルト：**operator**

この設定作業を完了すると、ユーザは以下の例に示すように、認証なしで装置に Telnet 接続できるようになります。

```
<Switch>
```

II. password 認証の設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. Telnet サーバを有効化する	**ip telnet server**	デフォルト：無効

操作	コマンド	補足
3. VTY line view または class view に移行する	• VTY line view に移行する **line vty** *first-number* [*last-number*] • VTY line class view に移行する **line class vty**	user line viewでの設定は、ユーザラインにのみ適用されます。user line class viewでの設定は、classのすべてのユーザに適用されます。 どちらかの設定でデフォルトから変更された場合、他のviewのデフォルト設定よりも優先されます。user line viewの設定がデフォルトから変更された場合、user line class viewでデフォルトから変更された場合よりも優先されます。 user line class viewの設定は、ログイン中のユーザには適用されません。新規ログインユーザにのみ適用されます。
4. password 認証を有効にする	**authentication-mode password**	デフォルト：password VTY line viewではprotocol inboundコマンドに関連します。 どちらかの設定がデフォルトから変更された場合、VTY line class viewの設定に関係なく、もう一方のコマンドはデフォルト設定を使用します。
5. password を設定する	**set authentication password** { **hash** | **simple** } *password*	デフォルト：設定なし
6. (オプション設定項目) ユーザロールを割り当てる	**user-role** *role-name*	デフォルト： **operator**

この設定作業を完了すると、ユーザは装置に Telnet 接続する際にパスワードを入力する必要があります。以下の例を参照してください。

```
Password:
<Switch>
```

III. scheme 認証の設定

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. Telnet サーバを有効化する	**ip telnet server**	デフォルト：無効

操作	コマンド	補足
3. VTY line view または class view に移行する	• VTY line view に移行する **line vty** *first-number* [*last-number*] • VTY line class view に移行する **line class vty**	user line viewでの設定は、ユーザラインにのみ適用されます。user line class viewでの設定は、classのすべてのユーザに適用されます。 どちらかの設定でデフォルトから変更された場合、他のviewのデフォルト設定よりも優先されます。user line viewの設定がデフォルトから変更された場合、user line class viewでデフォルトから変更された場合よりも優先されます。 user line class viewの設定は、ログイン中のユーザには適用されません。新規ログインユーザにのみ適用されます。
4. scheme 認証を有効にする	**authentication-mode scheme**	デフォルト：password VTY line viewではprotocol inboundコマンドに関連します。 どちらかの設定がデフォルトから変更された場合、VTY line class viewの設定に関係なく、もう一方のコマンドはデフォルト設定を使用します。

scheme 認証を使用するには、以下の作業も実行する必要があります。

- ISP domain view でログイン認証方法を設定します。
- リモート認証の場合は、RADIUS scheme を設定します。
- ローカルユーザアカウントを作成し、関連する設定を行います。

この設定作業を完了すると、ユーザは装置への Telnet 接続にユーザ名とパスワードが必要となります。以下の例を参照してください。

```
login: admin
Password:
<Switch>
```

4.3.2. 装置から Telnet サーバへの Telnet 接続

装置は Telnet クライアントとして Telnet サーバにログインすることができます。もし Telnet サーバが異なるサブネットにある場合、2 つの装置と Telnet サーバ間で通信できることを確認してください。

図 4-2 装置から Telnet サーバへの接続

以下に装置から Telnet サーバへのログインの設定を示します。

操作	コマンド	補足
1. 装置を使用して Telnet サーバにログインする	**telnet** [*ip-address* | *ipv6-address* | *domain-name*] [*tcp-port*]	—

4.4. SSHからのログイン

SSH は、より強固なセキュリティを持ったログイン方法のアプローチです。強力な暗号化と認証機能によって IP スプーフィング攻撃、パスワード傍受なども防止することができます。

装置のリモート管理を行うため、SSH クライアントを使用することができます。また SSH サーバの他の装置を管理するため、装置を SSH クライアントとして使用することができます。

デフォルトでは SSH からのログインは無効です。SSH ログインを設定するには、まず他の方法で装置にログインする必要があります。

4.4.1. SSH ログインの設定

この章では､SSH クライアント認証が password である場合の SSH サーバ設定手順を説明します。

以下に装置から SSH ログインの設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. ローカル鍵ペアを生成する	**crypto key generate** { **rsa** [**modulus** *modulus-size*] | **dsa** }	デフォルト：なし
3. SSH サーバを有効にする	**ssh server enable**	デフォルト：無効
4. (オプション設定項目) SSH ユーザを生成し、認証モードを指定する	**ssh user** *name* **authentication-method** { **password** | **publickey** *url* | **hostbased** *url* **host-name** *hostname* [*ip-address* | *ipv6-address*] }	デフォルト：設定なし

操作	コマンド	補足
5. VTY line view または class view に移行する	• VTY line view に移行する **line vty** *first-number* [*last-number*] • VTY line class view に移行する **line class vty**	user line viewでの設定は、ユーザラインにのみ適用されます。user line class viewでの設定は、classのすべてのユーザに適用されます。 どちらかの設定でデフォルトから変更された場合、他のviewのデフォルト設定よりも優先されます。user line viewの設定がデフォルトから変更された場合、user line class viewでデフォルトから変更された場合よりも優先されます。 user line class viewの設定は、ログイン中のユーザには適用されません。新規ログインユーザにのみ適用されます。
6. scheme 認証を有効にする	**authentication-mode scheme**	デフォルト：password VTY line viewではprotocol inboundコマンドに関連します。 どちらかの設定がデフォルトから変更された場合、VTY line class viewの設定に関係なく、もう一方のコマンドはデフォルト設定を使用します。
7. (オプション設定項目) 使用するプロトコルを指定する	**protocol inbound** { **all** | **ssh** | **telnet** }	デフォルト：Telnet、SSH ログイン中のユーザには適用しません。次回のログイン時に適用されます。 VTY line viewでは、**authentication-mode**コマンドに関連します。 どちらかの設定がデフォルトから変更された場合、もう一方のコマンドはVTY line class viewの設定に関わらずデフォルト設定を使用します。
8. system view に戻る	**quit**	—

4.4.2. 装置から SSH サーバへの SSH 接続

装置は SSH クライアントとして SSH サーバにログインすることができます。もし SSH サーバが異なるサブネットにある場合、2 つの装置と SSH サーバ間で通信できることを確認してください。

図 4-3 装置から SSH サーバへの SSH 接続

以下に user view で装置から SSH サーバへのログイン設定を示します。

操作	コマンド
IPv4 SSHサーバへのログイン	**ssh** [**-l** *username*] *ip-address*
IPv6 SSHサーバへのログイン	**ssh** [**-l** *username*] *ipv6-address*

SSH サーバを操作動作させるには、SSH クライアントの設定を行う必要があります。

4.5. CLIログインの表示と維持

display コマンドはすべての view で実行できます。

操作	コマンド	補足
オンラインのCLIユーザを表示する	**display users**	―
特定のユーザラインを解放する	**free line** { *number1* | { **aux** | **vty** } *number2* }	複数のユーザが同時に設定することができます。必要に応じて、このコマンドを使用してある接続を解放します。 自分が使用している接続を解放することはできません。 user viewで使用可能です。

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5章 SNMP によるアクセス

NMS で SNMP を実行することで、装置の MIB の GET、SET を行い、装置の管理/設定を行うことができます。

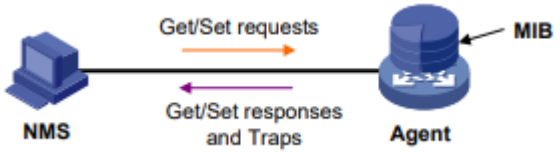

図 5-1 SNMP アクセス

装置は SNMPv1、SNMPv2c、SNMPv3 をサポートし、さまざまなネットワーク管理製品で動作します。NMS は同じ SNMP のバージョンを使用する必要があります。

デフォルトでは、SNMP は無効です。SNMP を使用して装置にアクセスするため、SNMP アクセス以外の他のログイン方法を用いて、SNMP アクセスの設定を行う必要があります。

SNMP の詳細については、オペレーションマニュアルのセクション 7 *システム管理* ”*SNMP* “を参照してください。

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6章　ログインユーザの制御

不正アクセスを防止するため ACL を使用し、ユーザのふるまいを監視および制御するため、コマンド認証とアカウンティングの設定を行います。

6.1. Telnet/SSHログインの制御

Telnet、SSH ログインをフィルタするため、異なる条件で ACL を使用します。

- 標準 IP ACL

このコマンドは、特定の回線（ライン）へのアクセスを制限するためにアクセスリストを指定します。1 つの回線には最大 2 つのアクセスリストを適用できます。既に 2 つのアクセスリストが適用されている場合、新しいアクセスリストの適用は拒否されます。適用済みのアクセスリストをこのコマンドの undo 形式で削除するまで、新しいアクセスリストの適用はできません。このコマンドはライン設定モードで使用可能です。指定したアクセスリストはコマンド実行時に存在する必要はありません。指定したアクセスリストが存在しない場合、コマンドは設定されていないものとして動作します。

6.1.1. 設定手順

以下に VTY ラインログインを制御する設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. VTY ラインログインをフィルタリングする ACL を適用する	• **ip acl** *name* • **line** { *first-number1* [*last-number1*] | **vty** *first-number2* [*last-number2*] } • **access-class** *ip-acl*	デフォルト：設定なし

メモ:

本設定によるフィルタリングでは暗黙の deny が適用されます。

6.1.2. 設定例

I. ネットワーク要件

図 6-1 に装置が Host A と Host B からの Telnet パケットのみを許可するように設定します。

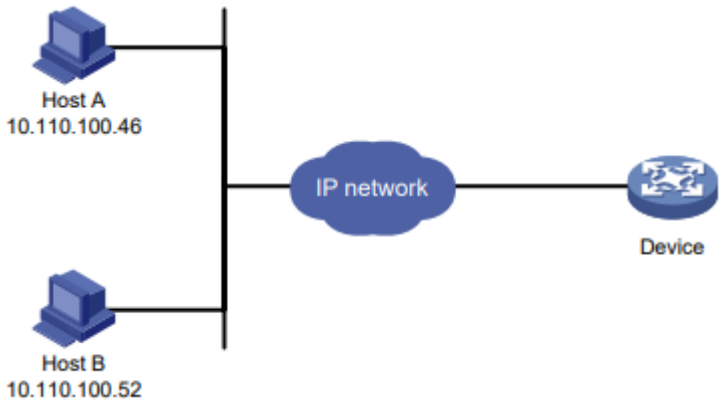

図 6-1 ネットワーク図

II. 設定手順

IP インタフェースを設定します。

```
<Switch> system-view
[Switch] interface vlan-interface 1
[Switch-Vlan-interface1] ip address 10.110.100.90 24
[Switch-Vlan-interface1] quit
```

Host A、Host B からのパケットを許可する ACL を設定します。

```
[Switch] ip acl ip1
[Switch-ip-acl-ip1] rule permit host 10.110.100.46 any
[Switch-ip-acl-ip1] quit
[Switch] ip acl ip2
[Switch-ip-acl-ip2] rule permit host 10.110.100.52 any
[Switch-ip-acl-ip2] quit
```

Telnet を有効化します。

```
[Switch] ip telnet server
```

ローカルユーザ abc を作成します。

```
[Switch] local-user abc
New local user added.
[Switch-luser-manage-abc] password simple abc12345
[Switch-luser-manage-abc] authorization-attribute user-role admin
[Switch-luser-manage-abc] service-type telnet
[Switch-luser-manage-abc] quit
```

Telnet ログインをフィルタする ACL を適用します。ユーザ名は abc、パスワードは abc12345 です。

```
[Switch] line vty 0 31
[Switch-line-vty0-2] access-class ip1
[Switch-line-vty0-2] access-class ip2
[Switch-line-vty0-2] authentication-mode scheme
[Switch-line-vty0-2]
```

6.2. SNMPアクセスの制御

送信元 IP アドレスによって SNMP アクセスを制御する標準 ACL（2000～2999）を使用します。要求された MIB view にアクセスするため、NMS は ACL によって許可された送信元 IP アドレスを使用する必要があります。ACL あるいはルールが設定されていない場合、アクセスの制御は適用されません。

6.2.1. 設定手順

以下に SNMPv1/v2c アクセスを制御する設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. SNMP アクセス権を設定する	• SNMP コミュニティ: **snmp-agent community** { **read** | **write** } [**simple** | **cipher**] *community-name* [**mib-view** *view-name*] [**acl** *acl-number* | **acl ipv6** *ipv6-acl-number*] * • SNMPv1/v2c グループ: **snmp-agent group** { **v1** | **v2c** } *group-name* [**read-view** *view-name*] [**write-view** *view-name*] [**notify-view** *view-name*] [**acl** *acl-number* | **acl ipv6** *ipv6-acl-number*] * • SNMPv1/v2c ユーザ: **snmp-agent usm-user** { **v1** | **v2c** } *user-name group-name* [**acl** *acl-number* | **acl ipv6** *ipv6-acl-number*] *	—

以下に SNMPv3 アクセスを制御する設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. SNMPv3 グループを作成し、ACL を指定する	**snmp-agent group v3** *group-name* [**authentication** | **privacy**] [**read-view** *view-name*] [**write-view** *view-name*] [**notify-view** *view-name*] [**acl** *acl-number* | **acl ipv6** *ipv6-acl-number*] *	—

3. SNMPv3 ユーザを作成し、ACL を指定する	**snmp-agent usm-user v3** *user-name group-name* [{ **cipher** | **simple** } **authentication-mode** { **md5** | **sha** } *auth-password* [**privacy-mode** { **aes128** | **des56** } *priv-password*]] [**acl** *acl-number* | **acl ipv6** *ipv6-acl-number*] *	—

メモ:

本設定によるフィルタリングでは暗黙の deny が適用されます。

6.2.2. 設定例

I. ネットワーク要件

図 6-2 のように Device が Host A と Host B からの SNMP のアクセスを許可するように設定します。

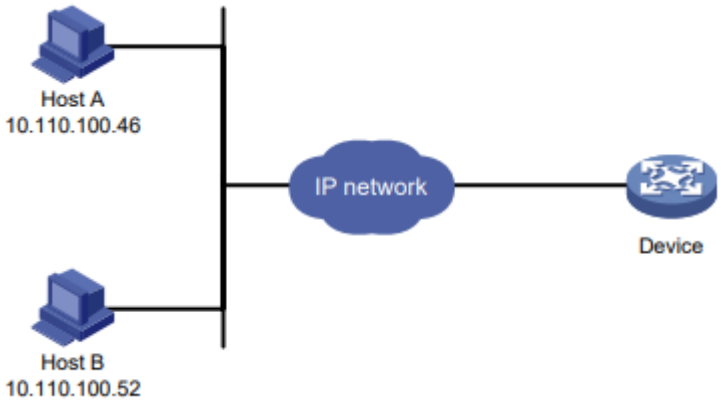

図 6-2 ネットワーク図

II. 設定手順

Host A、Host B からのパケットを許可する ACL を作成します。

```
<Switch> system-view
[Switch] ip acl SNMPACL 1
[Switch-ip-acl-SNMPACL] rule permit host 10.110.110.52 any
[Switch-ip-acl-SNMPACL] rule permit host 10.110.100.46 any
[Switch-ip-acl-SNMPACL] return
```

#SNMP コミュニティ、SNMP グループ、SNMP ユーザに関する ACL を適用します。

```
<Switch> system-view
[Switch] snmp-agent
[Switch] snmp-agent view Testview 1 included
[Switch] snmp-agent community TestCommunity view Testview read access SNMPACL
[Switch] snmp-agent group Testgroup v3 noauth read Testview write Testview notify Testview
```

```
access
SNMPACL
[Switch] snmp-agent user Testuser Testgroup access SNMPACL
[Switch] quit
```

6.3. コマンド認証の設定

デフォルトでは、ユーザが実行できるコマンドはユーザのユーザロールのみに依存します。認証モードが scheme の場合、コマンド認証機能を設定してコマンドへのアクセスをさらに制御することができます。

コマンド認証を有効にすると、ユーザは AAA スキームとユーザロールの両方で許可されたコマンドのみを使用できます。

コマンド認証方法は、ユーザログイン認証方法とは異なる場合があります。

この章では、コマンド認証の設定手順を説明します。コマンド認証機能を有効にするには、ISP domain view でコマンド認証方法を設定する必要があります。

6.3.1. 設定手順

以下にコマンド認証設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. user line view あるいは user line class view に移行する	• user line view に移行する **line** { *first-number1* [*last-number1*] | { **aux** | **vty** } *first-number2* [*last-number2*] } • user line class view に移行する **line class** { **aux** | **vty** }	—
3. スキーム認証を有効にする	**authentication-mode scheme**	—

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7章　ファイルシステム管理

7.1. 概要

7.1.1. ディレクトリ、ファイル名の指定

I. ディレクトリの指定

ディレクトリを指定する場合、絶対パスあるいは相対パスを使用することができます。たとえば、作業ディレクトリは **flash:/**です。図 7-1 の **test2** ディレクトリを指定する場合、以下の方法を使用することができます。

- **flash:/test/test1/test2** (絶対パス)
- **flash:/test/test1/test2/** (絶対パス)
- **test/test1/test2** (相対パス)
- **test/test1/test2/** (相対パス)

図 7-1 ディレクトリ階層の例

II. ファイルの指定

ファイルを指定する場合、以下の方法に従います。

- *filesystem/directory1/directory2/…/directoryn/filename* のフォーマットでファイルの絶対パスとファイル名を入力します。ここで *directoryn* はファイルが存在するディレクトリです。
- ファイルの相対パスとファイル名を入力してください。

たとえば、作業ディレクトリが **flash:/**です。ファイル **samplefile.cfg** は図 7-1 の **test2** ディレクトリにあります。ファイルを指定する場合、以下の方法を使用することができます。

- **flash:/test/test1/test2/samplefile.cfg**
- **test/test1/test2/samplefile.cfg**

7.2. ディレクトリの管理

7.2.1. ディレクトリ情報の表示

user view で以下の操作を実行します。

操作	コマンド	補足
ディレクトリあるいはファイルの情報を表示する	**dir** [**/all**] [*file* | *directory* | **/all-filesystems**]	複数のユーザが同時にファイル操作（ファイルやディレクトリの作成や削除など）を行うと、このコマンドの出力結果が不正確になる可能性があります。

7.2.2. 作業ディレクトリの変更

user view で以下の操作を実行します。

操作	コマンド
作業ディレクトリを変更する	**cd** { *directory* | **..** | */* }

7.2.3. ディレクトリの作成

user view で以下の操作を実行します。

操作	コマンド
ディレクトリを作成する	**mkdir** *directory*

7.2.4. ディレクトリ名の変更

user view で以下の操作を実行します。

操作	コマンド
ディレクトリの名前を変更する	**rename** *source-directory dest-directory*

7.2.5. ディレクトリの削除

ディレクトリを削除する場合、ディレクトリ内のすべてのファイルとサブディレクトリを削除する必要があります。ファイルを削除するには **delete** コマンドを使用します。サブディレクトリを削除する場合、**rmdir** コマンドを使用します。

操作	コマンド
ディレクトリを削除する	**rmdir** *directory*

7.3. ファイルの管理

コピー、ダウンロード、**save** コマンドを使用して、ファイルを作成することができます。

7.3.1. ファイル情報の表示

user view で以下の操作を実行します。

操作	コマンド	補足
ディレクトリまたはファイル情報を表示する	**dir** [**/all**] [*file* | *directory*]	複数のユーザが同時にファイル操作（ファイルやディレクトリの作成や削除など）を行う場合、このコマンドの出力は不正確になる可能性があります。

7.3.2. テキストファイルの内容表示

user view で以下の操作を実行します。

操作	コマンド
テキストファイルの内容を表示する	**more** *file*

7.3.3. ファイル名の変更

user view で以下の操作を実行します。

操作	コマンド
ファイル名を変更する	**rename** *source-file dest-file*

7.3.4. ファイルのコピー

user view で以下の操作を実行します。

操作	コマンド
ファイルをコピーする	**copy** *source-file* { *dest-file* | *dest-directory* }

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8章 コンフィグレーションファイル管理

8.1. 概要

コンフィグレーションファイルは CLI から管理できます。この章では、CLI からコンフィグレーションファイルを管理する方法を記載します。

コンフィグレーションファイルには、装置のソフトウェア機能を設定するためのコマンドのセットが保存されます。設定はコンフィグレーションファイルに保存できるため、設定は再起動後にも適用されます。将来使用するためにコンフィグレーションファイルをホストにバックアップすることもできます。

8.1.1. コンフィグレーションタイプ

装置には以下のコンフィグレーションタイプがあります。

- デフォルトコンフィグレーション
- スタートアップコンフィグレーション
- カレントコンフィグレーション

I. デフォルトコンフィグレーション

装置は、デフォルトコンフィグレーションと呼ばれる基本的な設定状態で出荷されます。これらのデフォルト設定により、起動コンフィグレーションファイルが存在しない場合やコンフィグレーションファイルが破損している場合でも、装置が正常に起動し動作することが保証されます。

デフォルトコンフィグレーションを表示するには、**reset system** コマンドを実行した後、**display current-configuration** コマンドを使用します。

II. スタートアップコンフィグレーション

装置は起動時にソフトウェア機能を設定するためにスタートアップコンフィグレーションを使用します。装置の起動後、次回の起動で使用するスタートアップコンフィグレーションファイルを指定することができます。このコンフィグレーションファイルは次回の起動で使用するスタートアップコンフィグレーションファイルと呼ばれます。スタートアップコンフィグレーションで起動されたのち、カレントコンフィグレーションファイルと呼ばれます。

次回の起動で使用するコンフィグレーションファイルが存在しない場合、装置は工場出荷時のデフォルト設定で起動します。

スタートアップコンフィグレーションの設定を表示するには以下の方法があります。

- **display startup** コマンドを実行します。詳細な設定を表示する場合、**more** コマンドを使用します。
- 装置の再起動後、設定変更を行う前に **display current-configuratio**n コマンドを実行してください。

III. カレントコンフィグレーション

装置が動作している現在のコンフィグレーションです。カレントコンフィグレーションはスタートアップコンフィグレーションと新しく設定したコンフィグレーションとなります。カレントコンフ

ィグレーションは一時的な記憶媒体に記録され、装置の再起動あるいは電源 OFF 時に削除されます。設定を削除しないようにするには、コンフィグレーションファイルにカレントコンフィグレーションを保存します。

カレントコンフィグレーションを表示するには、**display current-configuration** コマンドを使用します。

8.1.2. コンフィグレーションファイルの形式

設定の保存に指定するコンフィグレーションファイルの拡張子は、“.cfg”を使用する必要があります。“.cfg”ファイルは人が読めるテキストファイルであり、**more** コマンドを使用して表示することができます。

8.2. カレントコンフィグレーションの保存

カレントコンフィグレーションをコンフィグレーションファイルに保存するとき、次回に起動するコンフィグレーションファイルとして指定することができます。

すべての view でカレントコンフィグレーションを保存する方法を以下に示します。

操作	コマンド	補足
現在の設定をコンフィグレーションファイルに保存し、次回の起動に使用するスタートアップコンフィグレーションファイルに指定する	**save [force]**	forceパラメータを指定した場合、確認のプロンプトなしで既存の次回スタートアップコンフィグレーションファイルに保存することを指定します。

8.3. TFTPサーバへスタートアップコンフィグレーションファイルのバックアップ

以下に、次回の起動に使用するメインのスタートアップコンフィグレーションファイルを TFTP サーバにバックアップする設定を示します。

操作	コマンド	補足
1. (オプション設定項目) user view で指定されたスタートアップコンフィグレーションファイルを確認する	**display startup**	次回スタートアップコンフィグレーションファイルが指定されていない場合、あるいは指定されたコンフィグレーションファイルが存在しない場合、バックアップは失敗します。
2. TFTP サーバにスタートアップコンフィグレーションファイルをバックアップする	**copy startup-config** { **tftp:** [*//location/destination-url*] | **ftp:** [*//user-name:password@location:tcp-port/destination-url*]	―

8.4. TFTPサーバからスタートアップコンフィグレーションファイルの復元

TFTP サーバから装置にコンフィグレーションファイルをダウンロードし、そのファイルをメインの次回スタートアップコンフィグレーションファイルとして指定します。

以下に TFTP サーバからスタートアップアップコンフィグレーションファイルを復元する操作を示します。

操作	コマンド	補足
1. user view で TFTP サーバからスタートアップコンフィグレーションファイルを復元する	**copy** { **tftp:** [*//location/soure-url*] | **ftp:** [*//user-name:password@location:tcp-port/source-url*] **startup-config**	―
2. (オプション設定項目) メインの次回の起動で使用するように指定されたコンフィグレーションファイルが設定されていることを確認する	**display startup**	―

8.5. 次回の起動で使用するスタートアップコンフィグレーションファイルの削除

注意　：
この作業を行うと、次回の起動で使用するスタートアップコンフィグレーションファイルを、装置から完全に削除します。

次回の起動で使用するスタートアップコンフィグレーションファイルの削除することができます。

次回の起動で使用するコンフィグレーションファイルを削除した場合、次回の起動時にデフォルトコンフィグレーションで起動します。

たとえば、**reset saved-configuration** コマンドを実行すると、次回起動コンフィグレーションファイルは NULL に設定されます。

user view で以下の作業を実行します。

操作	コマンド	補足
次回の起動時のスタートアップコンフィグレーションファイルを削除する	**reset saved-configuration**	**Backup**あるいは**main**を指定しない場合、mainのスタートアップコンフィグレーションファイルが削除されます。

8.6. コンフィグレーションファイルの表示と維持

すべての view で **display** コマンドを実行、また user view で **reset** コマンドを実行できます。

操作	コマンド
カレントコンフィグレーションを表示する	**display current-configuration**
コンフィグレーションファイルの設定の差分を表示する	• **display diff configfile** *file-name-s* { **configfile** *file-name-d* | **current-configuration** | **startup-configuration** } • **display diff current-configuration** { **configfile** *file-name-d* | **startup-configuration** } • **display diff startup-configuration** { **configfile** *file-name-d* | **current-configuration** }
今回および次回の起動に使用するコンフィグレーションファイルを表示する	**display startup**
次回の起動時に使用するコンフィグレーションファイルを削除する	**reset saved-configuration**

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9章 ソフトウェアのアップグレード

9.1. 概要

ソフトウェアアップグレードは、新しい機能の追加や不具合を修正するために行います。

この章では、CLI からソフトウェアをアップグレードする方法について説明します。

9.1.1. ソフトウェアファイル名の規則

ソフトウェアイメージファイル名は、*device_name-v_number.bin* という形式でリリースされます。

9.2. アップグレードの準備

1. 現在のスタートアップソフトウェアバージョンを確認するため、**display version** コマンドを使用します。
2. アップグレードソフトウェアバージョンがネットワークに与える影響を確認するため、ソフトウェアアップグレードの以下のことを確認します。
   - ソフトウェアとハードウェアの互換性
   - ソフトウェアのアップグレードのバージョンとサイズ
   - 現在の Boot ROM イメージとアップグレードソフトウェアとの互換性
3. ソフトウェアのアップグレードに十分な記憶媒体を持っているかどうか確認するため、**dir** コマンドを使用します。記憶媒体に十分な空き容量がない場合、不要なファイルを **delete** コマンドで完全に削除します。
4. TFTP を設定します。
5. TFTP を使用してアップグレードソフトウェアファイルをダウンロードします。

9.3. スタートアップソフトウェアイメージの指定とアップグレードの完了

スタートアップソフトウェアファイルを指定し、アップグレードを完了するには、user view で以下の操作を実行します。

操作	コマンド	補足
1. 次回使用するスタートアップソフトウェアファイルを指定する	**boot-loader file** *ur*	**display boot**コマンドで確認できます。
2. カレントコンフィグレーションを保存する	**save**	再起動によって設定が削除されないように行います。
3. 装置の再起動	**reboot**	―

9.4. ソフトウェアアップグレード例

I. ネットワーク要件

図 9-1 に示すように、TFTP サーバを使用してソフトウェアファイルをアップグレードします。

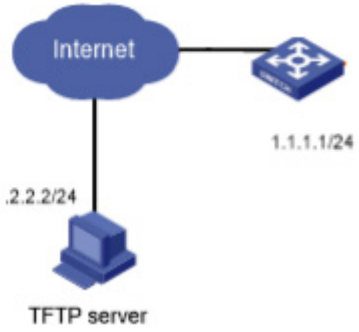

図 9-1 ネットワーク図

II. 設定手順

IP アドレスを設定し、装置と TFTP サーバが通信可能であることを確認します。(詳細は省略します。)

装置と TFTP サーバの両方で TFTP の設定を行います。(詳細は省略します。)

カレントソフトウェアの情報を表示します。

```
<Switch> display version
```

TFTP サーバからソフトウェアファイル new.bin をダウンロードします。

```
<Switch> copy tftp: //2.2.2.2/new.bin flash: new.bin
```

new.bin をスタートアップソフトウェアとして指定します。

```
<Switch> system-view
[Switch] boot-loader file new.bin
Whether to delete the previously used image? (y/n) [n] y
[Switch] quit
```

スタートアップソフトウェアの設定を確認します。

```
[Switch] display boot
```

装置の再起動を行い、アップグレードを完了させます。

```
<Switch> reboot
```

装置が正しいソフトウェアで動作しているか確認します。

```
<Switch> display version
```

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10章　装置管理

この章では装置の基本的なパラメータの設定、装置の管理について記載します。

この章の設定操作は、順番に関係なく実行できます。

10.1.　装置名の設定

装置名あるいは、“ホスト名”はネットワークで装置を特定するのに使用されます。システムとしては、装置名は CLI のプロンプトに対応します。装置名が **NEC** の場合、プロンプトは<NEC>です。

以下に装置名を設定する方法を示します

操作	コマンド	補足
1.　system view に移行する	**system-view**	―
2.　装置名を設定する	**sysname** *sysname*	デフォルト：装置名

10.2.　システムクロックの設定

正しいシステムクロックの設定はネットワーク管理と通信に不可欠です。ネットワークで装置を動作させる前に、装置のシステム時刻を設定してください。

装置はシステムクロックをローカルに設定するか、NTP クロックソースを使用して UTC 時刻を設定することができます。

- ローカルに設定したシステムクロックを使用する場合、装置はシステム時刻を維持するため、装置内部の水晶発振器によって生成されたクロック信号を使用します。

  装置の再起動を行うとローカルシステム時刻はデフォルトに戻るため､再度コマンドを設定してください。
- NTP ソースから UTC 時刻を取得した後、装置は UTC 時刻、タイムゾーン、サマータイムを用いてシステムクロックを計算します。その後、装置は定期的に UTC 時刻を同期し、システムクロックを再計算します。

NTP クロックソースから UTC 時刻を計算したほうが、ローカルで設定した時間よりも制度が高くなります。

以下にローカルでシステムクロックソースを設定する方法を示します。

操作	コマンド	補足
1.　system view に移行する	**system-view**	―
2.　システムクロックのソースを指定する	**ntp-service enable**	―
3.　user view に戻る	**quit**	―
4.　ローカルシステムクロックを設定する	**clock datetime** *time date*	―
5.　system view に移行する	**system-view**	―

操作	コマンド	補足
6. タイムゾーンを設定する	**clock timezone** *zone-name* { **add** | **minus** } *zone-offset*	デフォルト：UTC タイムゾーンを設定したのち、装置はシステム時刻を再計算します。システムクロックを確認する場合、**display clock**コマンドを使用します。 ネットワークのすべての装置で同一のタイムゾーンを使用していることを確認してください。
7. (オプション設定項目) サマータイムを設定する	**clock summer-time** *name start-time start-date end-time end-date add-time*	デフォルト：無効 サマータイムを設定したのち、装置はシステム時刻を再計算します。システムクロックを確認する場合、**display clock**コマンドを使用します。 ネットワークのすべての装置で同一のサマータイムを使用していることを確認してください。

以下に装置がクロックソースから UTC 時刻を取得し、システムクロックを計算する方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. タイムゾーンを設定する	**clock timezone** *zone-name* { **add** | **minus** } *zone-offset*	デフォルト：UTC タイムゾーンを設定したのち、装置はシステム時刻を再計算します。システムクロックを確認する場合、**display clock**コマンドを使用します。 ネットワークのすべての装置で同一のタイムゾーンを使用していることを確認してください。
3. (オプション設定項目) サマータイムを設定する	**clock summer-time** *name start-time start-date end-time end-date add-time*	デフォルト：無効 サマータイムを設定したのち、装置はシステム時刻を再計算します。システムクロックを確認する場合、**display clock**コマンドを使用します。 ネットワークのすべての装置で同一のサマータイムを使用していることを確認してください。

10.3. バナーの設定

バナーはユーザが装置にログインしたときにシステムが表示するプロンプト情報です。

10.3.1. バナーの種類

装置は以下のバナーをサポートしています。

- **Legal バナー** – 著作権表示の後に表示されます。ログインを続行するには、ユーザは **Y** を入力するか **Enter** キーを押してください。**N** を入力すると、ユーザはログインプロセスを終了します。**Y**、**N** は、大文字でも小文字でもかまいません。
- **Message of the Day (MOTD)バナー** –legal バナーの後、login バナーの前に表示されます。
  Login バナー – パスワードとスキーム認証が設定されている場合にのみ表示されます。
- **Incoming バナー** – モデムユーザ向けに表示されます。
- **Shell バナー** – モデム以外のユーザに表示され、ログインユーザが user view にアクセスした後に表示します。

システムは Legal バナー、MOTD バナー、Login バナー、Incoming または Shell バナーの順番で表示します。

10.4. 装置の再起動

⚠ 注意　:

- ネットワークサービスに割り込んで再起動する可能性があります。
- 設定が消失するのを避けるため、装置を再起動する前に **save** コマンドでカレントコンフィグレーションを保存してください。
- 再起動前に、**display startup** コマンドを使用してスタートアップコンフィグレーションファイルとソフトウェアイメージが正しく指定されていることを確認してください。スタートアップコンフィグレーションファイルあるいはソフトウェアイメージが異常である場合、装置は正常に起動しません。

遠隔ホストから CLI により装置を再起動することができます。

データ保護のため、ファイルを操作している場合、再起動は行われません。

10.4.1. CLI による装置の即時再起動

user view で以下のコマンドを実行します。

操作	コマンド	補足
装置を再起動する	**reboot** [**force**]	―

10.5. スケジュール自動実行の設定

10.5.1. 設定ガイドライン

以下にスケジュール自動実行の設定のガイドラインを示します。

- システムクロックは再起動により常に一旦デフォルトに戻ります。スケジュール自動実行を期待通りに動作させる為に、再起動後にシステムクロックを再設定あるいは NTP を設定してください。
- コマンド（コマンド A）を job に割り当てるため、コマンド A の view に移行するコマンドを job に割り当ててください。
- スケジュール内の全コマンドがコマンド構文に準拠していることを確認してください。システムはジョブへのコマンド割り当て時に構文チェックを行いません。
- **telnet**、**ftp**、**ssh2**、および **monitor process** コマンドはスケジュール自動実行することはできません。
- スケジュールはユーザの操作をサポートしていません。もしコマンドが”YES”あるいは”NO”の答えを要求する場合、システムは常に”Y”あるいは”YES”が入力されます。もし文字列の入力が必要な場合、システムは自動的にデフォルト文字列を入力するか、デフォルト文字列がない場合、空の文字列を入力します。
- スケジュールはバックグラウンドで実行され、ログ、トラップ、デバッグ情報を除き、スケジュールに関する出力は表示されません。

10.6. 装置の温度アラームのしきい値の設定

装置は以下のしきい値を温度センサによってモニタします。

- 低温しきい値
- 高温しきい値

温度が低温しきい値を下回った場合、または高温しきい値に達した場合、装置は以下の操作を実行します。

- ログメッセージとトラップを送信します。

以下に温度アラームしきい値を設定する方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. 温度アラームしきい値を設定する	**environment temperature threshold thermal** *thermal-id* [**high** *value*] [**low** *value*]	―

10.7. トランシーバの情報表示

10.7.1. トランシーバの情報表示

実装しているトランシーバの情報を確認するために以下の内容を表示することができます。

- 実装しているトランシーバタイプ、コネクタタイプ、送信するレーザーの中心波長、転送距離、ベンダ名などの主要パラメータ
- 電子ラベルを表示します。電子ラベルはトランシーバモジュールのプロファイルであり、シリアル番号、製造年月日、ベンダ名などの恒久的な構成情報を含みます。このデータは、トランシーバモジュールまたは装置のデバッグやテスト中に、トランシーバモジュールまたは装置のストレージコンポーネントに書き込まれます。

装置は定期的にトランシーバモジュールのベンダ名を確認します。トランシーバモジュールにベンダ名がない場合、またはベンダ名が NEC でない場合、装置はトラップとログメッセージを送出し

続けます。ログ生成の詳細については、オペレーションマニュアルのセクション 7 *システム管理 "Information Center"*を参照してください。

トランシーバモジュールを確認するには、任意の view で以下のコマンドを実行します。

操作	コマンド	補足
トランシーバモジュールの主要パラメータを表示する	**display transceiver interface** [*interface-type interface-number*]	―

10.8. 装置管理の情報表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
システムクロック、日時、タイムゾーン、サマータイムを表示する	**display clock**
装置の製造情報を表示する	**display device manuinfo**
装置の温度情報を表示する.	**display environment**
メモリ使用統計を表示する	**display memory utilization**
システムバージョン情報を表示する	**display version**

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11章 Auto Config

11.1. 概要

Auto Config は、スタートアップコンフィグレーションファイルを設定されていない状態で装置が起動する場合、自動でコンフィグレーションファイルを取得し、適用することを可能にします。この機能により、ネットワーク設定と保守を簡素化することができます。

Auto Config は、DHCP サーバやファイルサーバ（TFTP サーバ）を含むサーバによって Auto Config を実現します。

Auto Config は、以下の特徴を持つシナリオに適用されます。

- 設定が必要な装置が多数存在する。
- 設定対象装置が広範囲に分散している。
- 各装置における設定作業負荷が大きい。

11.2. Auto Configの設定作業リスト

作業リスト
(必須設定項目) ファイルサーバの設定
(必須設定項目) Auto Configファイルの準備
(必須設定項目) Auto Configの起動と完了

11.3. ファイルサーバの設定

装置が TFTP サーバからコンフィグレーションファイルを取得するには、ファイルサーバ上の TFTP サービスを有効にください。

11.4. Auto Configファイルの準備

装置は Auto Config にスクリプトファイルまたはコンフィグレーションファイルを使用できます。

- 装置が Auto Config にコンフィグレーションファイルを使用するには、「コンフィグレーションファイル」の説明に従ってコンフィグレーションファイルを作成し、ファイルサーバに保存する必要があります。DHCP サーバ上でコンフィグレーションファイル名の割り当てを行わない場合、TFTP サーバ上のホスト名ファイルも作成する必要があります。
- 装置が Auto Config にスクリプトファイルを使用するには、ファイルサーバにスクリプトファイルを作成して保存する必要があります。

11.4.1. コンフィグレーションファイル

以下にコンフィグレーションファイルの準備を示します。

- それぞれに異なったコンフィグレーションを必要とする装置については、以下の作業を実行してください。
  - 各装置のコンフィグレーションファイル名を決めます。

    コンフィグレーションファイル名には拡張子.cfg を使用する必要があります。ファイル名の識別を容易にするため、コンフィグレーションファイル名にはスペースを含めないでください。
  - ファイル名を使用して、装置のコンフィグレーションファイルをファイルサーバに保存します。
- 全ての設定、または部分的に設定が共有となる装置については、共通となる部分のコンフィグレーションを含むファイル.cfg を用意し、ファイルサーバに保存します。
- TFTP を使用する場合、装置のスタートアップに必要な共通コンフィグレーションを device.cfg ファイルとしてファイルサーバに保存することができます。このファイルは、装置を使用する時に他の一切のコンフィグレーションの変更を必要としない場合にのみ、装置に適用されます。

Auto Config プロセス中、装置はまず自身専用のコンフィグレーションファイルを取得しようと試みます。専用のコンフィグレーションファイルが見つからない場合、装置は共通コンフィグレーションファイルの取得を試みます。TFTP ファイルサーバを使用している場合、共通コンフィグレーションファイルが見つからないと、装置はデフォルトコンフィグレーションファイルを取得して使用します。

11.5. Auto Configの起動と完了

1. Auto Config 対象の装置の電源を入れます。

   装置が startup-configuration の設定ファイルを検出しない場合は、Auto Config がプロセスを起動して設定ファイルを取得します。1 回の試行が失敗すると、装置は 30 秒待機した後、自動的にプロセスを再起動します。プロセスを停止するには、**Ctrl+C** または **Ctrl+D** を押下します。

   コンフィグレーションファイルを取得後、装置は自動的にコンフィグレーションファイルを実行します。
2. **save** コマンドを使用して、実行中の設定を保存します。

   装置は取得したコンフィグレーションファイルをローカルに保存しません。設定を保存しない場合、装置は再起動後に Auto Config 機能を再度使用する必要があります。

11.6. Auto Configの設定例

11.6.1. TFTP サーバを使用した Auto Config の設定例

I. ネットワーク要件

図 11-1 に示すように、Switch A は DHCP サーバからコンフィグレーションファイルを取得します。

サーバとゲートウェイを設定し、アクセスデバイスが次のタスクを完了するためのコンフィグレーションファイルを取得できるようにしてください。

- アクセスデバイスの管理者が、それぞれのアクセスデバイスに Telnet 接続して管理できるようにします。
- ログイン時に管理者にそれぞれのユーザ名とパスワードの入力を要求します。
- vlan 2 を作成します。

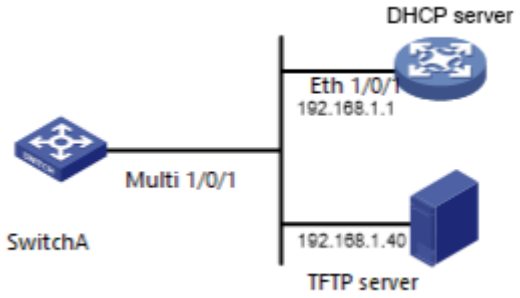

図 11-1 ネットワーク図

II. 設定手順

1. DHCP サーバを設定します。(詳細は省略します)
2. Switch A の設定を *autoconfig.cfg* という名前で保存し、TFTP サーバにコピーします。

```
<Switch> system-view
[Switch] interface vlan 1
[Switch-Vlan-interface1] ip address 192.168.1.2 24
[Switch-Vlan-interface1] quit
[Switch] local-user admin
[Switch-luser-manage-admin] authorization-attribute user-role admin
[Switch-luser-manage-admin] password simple 12345678
[Switch-luser-manage-admin] service-type terminal telnet
[Switch-luser-manage-admin] quit
[Switch-line-aux0] authentication-mode scheme
[Switch-line-aux0] quit
[Switch] line vty 0
[Switch-line-vty0] authentication-mode scheme
[Switch-line-vty0] quit
[Switch] ip telnet server
[Switch] vlan 2
[Switch-vlan2] quit
[Switch] quit
<Switch> copy current-configuration tftp: //192.168.1.40/autoconfig.cfg
```

TFTP サービスソフトウェアを起動します。(詳細は省略します)

保存済みの設定をリセットし、Switch A を再起動します。Switch A は Auto Config により設定を取得します。

```
<Switch> reset saved-configuration
The saved configuration file will be erased. Are you sure? [Y/N]:y
Configuration file in flash: is being cleared.
```

```
Please wait ......
Configuration file is cleared.
<Switch> reboo
Please wait for loading ...
Starting SwitchLinux ... 100 %
 UART init ..................................................... 100 %
 Starting runtime image
 Device Discovery .............................................. 100 %
 Configuration init ............................................ 100 %
Startup configuration file doesn't exist or is invalid.
Starting the zero-touch process... Press CTRL_C or CTRL_D to abort.
Zero-touch process started successfully after 1 attempts.
Interface used: Vlan1
Enable DHCP client on Vlan1
Failed to obtain configure from NetMeister.
Performing automatic configuration... Press CTRL_C or CTRL_D to abort.
Automatic configuration attempt: 1.
Interface used: Vlan1
Enable DHCP client on Vlan1
Try to download configure from TFTP://192.168.1.40/autoconfig.cfg......
Accessing tftp:......
Transmission start......
Transmission finished, file length 1421 bytes.
Please wait, save configure to file autoconfig.cfg ...... Done.
Set autoconfig.cfg as boot configure OK
The configuration file has been obtained, and the system is rebooting..
```

III. 設定の確認

```
Line aux0 is available.
Press ENTER to get started.
User Access Verification
Username:admin
Password:********
<Switch> display current-configuration
Building configuration...
Current configuration : 1262 bytes
!
version 1.0.14
!
username admin password 0 12345678
username admin privilege 15
!
line aux 0
login local
!
line telnet
login local
```

```
<Switch>display vlan
VLAN 1
 Name : default
 Description :
 Tagged Member Ports :
 Untagged Member Ports : multi1/0/1-1/0/16, ten1/0/17-1/0/20
VLAN 2
 Name : VLAN0002
 Description :
 Tagged Member Ports :
 Untagged Member Ports :
Total Entries : 2
```

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

2. アクセス

本マニュアルは以下に示す章で構成されています。

01-Ethernet インタフェース

02-Interface range

03-MAC アドレステーブル

04-リンクアグリゲーション

05-LLDP

06-ループ検出

07-VLAN

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1.2. Ethernet インタフェースの共通設定 1-1
1.2.1. ジャンボフレームの設定 1-1
1.2.2. Ethernet インタフェースの一般的なフロー制御の設定 1-2
1.2.3. ストーム抑制機能の設定 1-2
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1.4. Ethernet インタフェースの表示と維持 1-5

1章 Ethernet インタフェース

装置は、Ethernet インタフェース、マネジメント Ethernet インタフェース、コンソールインタフェース、および USB インタフェースをサポートしています。装置の種類によってサポートされるインタフェースタイプと番号が異なります。インタフェースタイプと番号については、インスタレーションマニュアルを参照してください。

この章では、マネジメント Ethernet インタフェースと Ethernet インタフェースの設定方法について記載します。

1.1. Ethernetインタフェースの命名ルール

Ethernet インタフェースは、*interface type A/B/C* のフォーマットで指定されます。文字は以下のインタフェースタイプを表します。

- **A** – IRF スタックメンバ ID または仮想スロット番号。IRF スタックがない場合、A はデフォルトで 1 になります。
- **B** – 装置のスロット番号。固定インタフェースは 0 となります。
- **C** – インタフェース番号。

1.2. Ethernetインタフェースの共通設定

この章では、Ethernet インタフェースの共通設定について記載します。

以下にマネジメント Ethernet インタフェースを設定する手順を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	ー
2. Ethernet interface view に移行する	**interface** *interface-id*	ー
3. (オプション設定項目) インタフェースの説明を設定する	**description** *text*	デフォルト：Null
4. (オプション設定項目) インタフェースをシャットダウンする	**shutdown**	デフォルト：up

1.2.1. ジャンボフレームの設定

Ethernet で起こる莫大な量のトラフィックにより、フレームが Ethernet フレームの標準サイズよりも大きくなることがあります。このようなフレーム（ジャンボフレームと呼ばれます）が Ethernet ポートを通過できるようにすることで、標準サイズより大きなフレーム（ただし指定したパラメータ範囲内のもの） を転送できます。。

- Ethernet インタフェースでジャンボフレームの設定が無効（**undo jumboframe enable** コマンド）にされているとき、ジャンボフレームの処理を行わないで廃棄します。
- Ethernet インタフェースでジャンボフレームの設定が行われているとき、以下の処理を行います。
  - 指定したフレーム長でジャンボフレームを処理します。
  - 指定したフレーム長を超過したフレームは処理を行わないで廃棄します。

以下にジャンボフレームを設定する手順を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. Ethernet interface view に移行する	**interface** *interface-id*	—
3. ジャンボフレームサポートを設定する	**jumboframe enable** [*value*]	デフォルト：9600バイトのジャンボフレームが可能です。

1.2.2. Ethernet インタフェースの一般的なフロー制御の設定

リンクのエンド間で一般的なフロー制御を有効にすることで、リンクでのパケット廃棄を防ぐことができます。受信エンドでフロー制御を有効にすると、フロー制御（Pause フレーム）を送信エンドに通知し、トラフィック輻輳が発生した際に一時的にパケットの送信を停止することができます。一般的なフロー制御には、次のタイプがあります。

- **TxRx モードフロー制御** – **flowcontrol** コマンドを使用して有効にします。インタフェースは送受信の両方のフロー制御を有効にすることができます。
  - 輻輳が発生すると、インタフェースはピアにフロー制御フレームを送信します。
  - インタフェースはピアからフロー制御フレームを受信したとき、パケットの送信を停止します。

リンク上の単方向トラフィック輻輳を処理するには、一方の端で **flowcontrol** コマンドを設定します。リンクの両端でトラフィック輻輳を処理できるようにするには、両端で **flowcontrol** コマンドを設定します。

以下に Ethernet インタフェースでフロー制御の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. Ethernet interface view に移行する	**interface** *interface-id*	—
3. フロー制御を有効にする	TxRxモードフロー制御を有効にする **flowcontrol**	デフォルト：無効

1.2.3. ストーム抑制機能の設定

ストーム抑制により、インタフェースでブロードキャスト、マルチキャスト、不明なユニキャストトラフィックの制御ができます。ブロードキャスト、マルチキャスト、不明なユニキャストトラフ

ィックがしきい値を超過しているとき、装置は、トラフィックがしきい値を下回るまでパケットを廃棄します。

ストーム抑制とストーム抑止の両方でインタフェースのトラフィックを抑制することができます。ストーム抑制はトラフィックを抑制するため、ハードウェアのチップを使用します。ストーム抑止はトラフィックを制御するためソフトウェアを使用します。ストーム抑制はストーム抑止に比べて装置への影響が少なくなります。

I. 設定手順

以下に Ethernet インタフェースでストーム抑制のしきい値を設定する手順を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. 抑制グローバルメーターモードを設定する	**suppression level** { **pps** | **kbps** | **percentage** }	デフォルト：**pps**
3. Ethernet interface view に移行する	**interface** *interface-id*	―
4. ブロードキャストパケット転送抑制を設定し、しきい値を設定する	**suppression broadcast level** { **pps** *pps-rise* | **kbps** *kbps-rise* | *level-rise* }	デフォルト：すべてのブロードキャストを通過します。
5. マルチキャストパケット転送抑制を設定し、しきい値を設定する	**suppression multicast level** { **pps** *pps-rise* | **kbps** *kbps-rise* | *level-rise* }	デフォルト：すべてのマルチキャストを通過します。
6. 不明なユニキャストパケット転送抑制を設定し、しきい値を設定する	**suppression unicast level** { **pps** *pps-rise* | **kbps** *kbps-rise* | *level-rise* }	デフォルト：すべての不明なユニキャストを通過します。

1.3. Layer 2 Ethernetインタフェースの設定

1.3.1. Ethernet インタフェースのストーム抑止の設定

I. 概要

ストーム抑止は、ブロードキャスト、マルチキャスト、不明なユニキャストトラフィックを Ethernet インタフェースで受信した各トラフィックと比較します。ストーム抑止は、トラフィックの各タイプにしきい値の下限と上限があります。

インタフェースのトラフィックが上限のしきい値を超えた場合、インタフェースは設定によって以下のどちらかのアクションを行います。

- **action shutdown** - しきい値の上限に達したときにポートをシャットダウンします。
- **action block** - しきい値の上限に達したときにポートをブロックします。
- **action none** - ストームパケットをフィルタリングしないことを設定します。

ストーム抑制とストーム抑止の両方が、インタフェース上のストームを抑制できます。ストーム抑制はチップを使用してトラフィックを抑制します。ストーム抑制は、ソフトウェアを使用してトラフィックを抑制するストーム抑止よりも、装置の性能への影響が少ないです。

II. 設定手順

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. (オプション設定項目) ストーム抑止のポーリング間隔を設定する	**storm-constrain polling interval** *seconds*	デフォルト：10秒 ネットワークの信頼性のため、デフォルト値以上の値を設定してください。
3. ストーム抑止グローバルメーターモードを設定する	**storm-constrain level** { **pps** | **kbps** | **percentage** }	デフォルト：**pps**
4. Ethernet interface view に移行する	**interface** *interface-id*	―
5. (オプション設定項目) ストーム抑止の設定を有効にし、ブロードキャスト、マルチキャスト、または不明なユニキャストトラフィックの上限/下限を設定する	**storm-constrain** { { **broadcast** | **multicast** | **unicast** } **level** { **pps** *pps-rise* [*pps-low*] | **kbps** *kbps-rise* [*kbps-low*] | *level-rise* [*level-low*] } | **action** { **shutdown** | **block** | **none** } }	デフォルト：無効

1.3.2. Ethernet インタフェースの MDIX モードの設定

重要:

MDIX モードの機能は、SFP+ポートで未サポートです。

物理 Ethernet インタフェースは、8 ピンのケーブルを使用します。各ピンはそれぞれ固有の役割があります。たとえば、ピン 1 とピン 2 は信号を送信し、ピン 3 とピン 6 は信号を受信します。Ethernet インタフェースに接続するためクロスオーバーケーブルとストレートケーブルの両方を使用することができます。。Ethernet インタフェースが自動でケーブルタイプを適用させるため、以下の MDIX（Medium Dependent Interface-Crossover）モードのいずれかで動作します。

- **cross モード** – ピン 1、ピン 2 は信号を受信し、ピン 3 とピン 6 は信号を送信します。
- **normal モード** – ピン 1、ピン 2 は信号を送信し、ピン 3 とピン 6 は信号を受信します。
- **Auto モード** – ピア間でインタフェースのネゴシエーションが行われます。

メモ:

この機能は物理インタフェースのピン 4、ピン 5、ピン 7、ピン 8 に影響しません。

- 10Mbps あるいは 100Mbps で動作するインタフェースのピン 4、ピン 5、ピン 7、ピン 8 は信号の送受信を行いません。
- 1000Mbps で動作するインタフェースのピン 4、ピン 5、ピン 7、ピン 8 は信号の送受信を行います。

ピア間でインタフェースと通信できるように、以下のガイドラインに従ってインタフェースの MDIX モードを設定してください。

- 通常、インタフェースの MDIX モードを Auto MDIX に設定してください。装置がケーブルタイプを確定できないとき、インタフェースの MDIX モードを normal または cross に設定してください。
- ストレートケーブルを使用する場合、インタフェースをピアと異なる MDIX モードで動作するように設定してください。
- クロスオーバーケーブルを使用する場合、、以下のいずれかのモードに設定してください。
  - インタフェースを、ピアと同じ MDIX モードで動作するように設定します。
  - どちらか一端を Auto MDIX モードで動作するように設定します。

以下に Ethernet インタフェースに MDIX モードを設定する手順を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. Ethernet interface view に移行する	**interface** *interface-id*	—
3. Ethernet インタフェースの MDIX モードを設定する	**mdix** { **auto** | **normal** | **cross** }	デフォルト：auto

1.3.3. Ethernet インタフェースのケーブル接続テスト

重要:

Ethernet インタフェースがリンクアップ状態の場合、ケーブル接続をテストするとリンクダウンし、その後再びリンクアップします。

メモ:

ケーブル接続テストは、SFP+ポートに設定できません。

この機能は Ethernet インタフェースのケーブル接続をテストし、ケーブルテスト結果を表示します。結果にはケーブルの状態と複数の物理パラメータが含まれます。障害が検出された場合、結果はローカルポートから障害発生点までの距離を表示します。

以下に Ethernet インタフェースのケーブル接続テストを行う手順を示します。

操作	コマンド	補足
1. Ethernet インタフェースに接続されたケーブルをテストする	**test Virtual-Cable-Test interface** *interface-id* [**to** *interface-id*]	—

1.4. Ethernetインタフェースの表示と維持

すべての view で **display** コマンドを実行し、user view で **reset** コマンドを実行できます。

操作	コマンド
インタフェースのトラフィック統計情報を表示する	**display counters interface** [*interface-type* [*interface-number*]]

操作	コマンド
最後のポーリング間隔からトラフィックレートの統計情報を表示する	**display interface** [*interface-type* [*interface-number*]] **utilization**
指定されたインタフェースの動作情報およびステータス情報を表示する	**display interface** [*interface-type* [*interface-number*]] [**status** | **description**]
指定されたインタフェース上のドロップされたパケットに関する情報を表示する	**display interface** [*interface-type* [*interface-number*]] **counters** [**errors**]
指定されたインタフェースのストーム抑止に関する情報を表示する	**display storm-constrain interface** *interface-list* [**broadcast** | **multicast** | **unicast**]
インタフェースの統計情報を削除する	**reset counters** { **all** | **interface** [*interface-type* [*interface-number*]] }

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2章 Interface range

interface range コマンドはインタフェースレンジを作成し、interface range view に移行します。同じ機能を 1 つずつインタフェースに設定する代わりに、interface range view に移行して、複数のインタフェースをまとめて実行することができます。たとえば、複数のインタフェースをまとめてシャットダウンする場合、interface range view で **shutdown** コマンドを実行します。

2.1. 制限とガイドライン

interface range view で interface range を使用する際は、以下の点に注意してください。

- interface range view では、interface range コマンドで最初に指定したインタフェースでサポートされるコマンドのみ有効です。
- interface interface-type interface-number コマンドで interface view に移行できない場合、interface range で最初に指定したインタフェースでインタフェース設定をしないでください。
- リンクアグリゲーションのアグリゲートインタフェースとメンバポートを同じ interface range に設定しないでください。設定した場合、あるコマンドによってリンクアグリゲーションが失敗することがあります。
- interface range のインタフェースの最大数に制限はありませんが、interface range でのインタフェースが多くなれば、実行時間も長くなります。
- 1000 個以上の interface range name を作成しないでください。
- interface range view でコマンドを実行した後、以下の状態の 1 つになります。
  - システムはエラーメッセージを表示し、interface range view にとどまります。これは 1 つ以上のメンバインタフェースで実行が失敗したことを示します。
    - インタフェースレンジの最初に指定したインタフェースでコマンドの実行に失敗した場合、他のメンバインタフェースで実行されません。
    - 最初に指定したインタフェースではないインタフェースで、コマンドの実行に失敗した場合、残りのメンバインタフェースでコマンドが適用されます。
  - システムは system view に戻ります。これは以下のことを意味します。
    - コマンドは system view と interface view の両方でサポートします。
    - interface range view のメンバインタフェースで実行が失敗し、system view で成功します。
    - コマンドは後続のメンバインタフェースで実行しません。

system view の設定が必要でない場合、undo コマンドで設定を削除することができます。

2.2. 設定手順

操作	コマンド	補足
1. system view へ移行する	**system-view**	—

操作	コマンド	補足
2. Interface range view へ移行する	**interface range** { *interface-type interface-number* [**to** *interface-type interface-number*] }	―
3. （オプション設定項目）最初に指定したインタフェースで有効なコマンドを表示する	Interface range viewで”?”を入力する	―
4. 利用可能なコマンドを使用してインタフェースを設定する	有効なコマンドはインタフェースによって異なる	―

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3章 MAC アドレステーブル

3.1. 概要

Ethernet 装置は、フレームを転送するために MAC アドレステーブルを使用します。このテーブルは、宛先 MAC アドレス、出力インタフェース、VLAN ID を記載しています。フレームを転送した場合、装置は最初に MAC アドレステーブルにフレームの MAC アドレスと一致するか検索します。

- エントリがある場合、出力インタフェースへパケットを転送します。
- エントリがない場合､装置はフレームが所属する VLAN 内でフレームをフラッディングします。

3.1.1. MAC アドレスエントリの作成方法

MAC アドレステーブルのエントリには、装置によって自動的に学習されたエントリと手動で追加されたエントリが含まれます。

I. MAC アドレスの学習

装置は､各インタフェースで受信したフレームの送信元 MAC アドレスを学習することにより､MAC アドレステーブルを自動的に生成します。

装置は、受信パケットの送信元 MAC アドレスを学習するために以下の処理を行います。

1. フレームの送信元 MAC アドレス（例：MAC-SOURCE）を確認します。
2. MAC アドレステーブルで送信元 MAC アドレスを検索します。
    - エントリがある場合、装置はそのエントリを更新します。
    - エントリがない場合、装置は MAC-SOURCE と受信ポートのエントリを追加します。

この送信元 MAC アドレスを学習した後、MAC-SOURCE 宛てのフレームを受信すると、装置は以下の処理を行います。

3. MAC アドレステーブルから MAC-SOURCE エントリを検索します。
4. エントリのポートからフレームを転送します。

装置は、不明な送信元 MAC アドレスのフレームを受信したとき、MAC アドレステーブルが完全に書き込まれるまで、毎回学習プロセスを行います。

II. MAC アドレスエントリの手動設定

装置が送信元 MAC アドレス学習を介して動的に MAC アドレスを学習するとき､装置は正規ユーザのフレームかハッカーからのフレームかを見分けることができません。これは潜在的にセキュリティに危険をもたらします。ホスト A がポート A に接続されているとき、MAC アドレスエントリはホスト A の MAC アドレス（たとえば、MAC A）を学習します。不正なユーザがポート B への送信元 MAC アドレスとして MAC A のフレームを送信するとき、装置は以下の処理を行います。

1. 出力インタフェースとしてポート B の新しい MAC アドレスエントリを学習し､MAC A の古いエントリに上書きします。
2. ポート B から MAC A の宛先のフレームを不正ユーザに転送します。

その結果、不正なユーザはホスト A のデータを取得します。ポート A のセキュリティを強化するために、ホスト A をポート A と結合するため、スタティックエントリを手動で設定します。ホス

ト A のフレームは常にポート A に向けて送信されます。ホスト A の偽造した MAC アドレスを使っている他のホストはホスト A の宛先フレームを取得することができません。

3.1.2. MAC アドレスエントリのタイプ

MAC アドレステーブルには以下のタイプのエントリがあります。

- **スタティックエントリ** – スタティックエントリは、関連したインタフェースから特定の宛先 MAC アドレスによってフレームを転送するため、手動で設定されます。エージアウトしません。スタティックエントリはダイナミックエントリよりも優先されます。
- **ダイナミックエントリ** – ダイナミックエントリは、関連付けられたインタフェースから特定の宛先 MAC アドレスを持つフレームを転送するために動的に学習されます。ダイナミックエントリはエージアウトする可能性があります。

スタティック MAC アドレスエントリはダイナミック MAC アドレスに上書きすることができます。逆にダイナミック MAC アドレスは上書きすることができません。

3.2. MACアドレス設定作業リスト

この項で記載される設定項目はすべてオプション設定であり、設定する順番は関係ありません。

スタティックおよびダイナミック MAC アドレスエントリを含む、ユニキャスト MAC アドレスエントリの設定のみを扱います。

MAC アドレステーブルを設定するには、以下の項目を実行します。

作業リスト
(オプション設定項目) MACアドレスエントリの設定 • グローバルでのスタティック/ダイナミック MAC アドレスエントリの追加
(オプション設定項目) MACアドレス学習の無効化
(オプション設定項目)ダイナミックMACアドレスエントリのエージングタイマの設定

3.3. MACアドレスエントリの設定

3.3.1. 設定ガイドライン

- 自動学習した MAC アドレスと異なる出力インタフェースで同じ MAC アドレスが存在する場合、ダイナミック MAC アドレスエントリを追加することはできません。
- 設定を保存しない場合、手動で設定したスタティック MAC アドレスエントリは、再起動が行われると削除されます。手動で設定されたダイナミック MAC アドレスは設定を保存するあるいはしないに関わらず、削除されます。

送信元 MAC アドレスが異なるタイプの MAC アドレスエントリと一致するフレームは、それぞれ異なる方法で処理されます。

タイプ	説明
スタティックMACアドレスエントリ	フレームの入力インタフェースがエントリと同一であるかどうかにかかわらず、宛先MACアドレスに基づいてフレームを転送します。
ダイナミックMACアドレスエントリ	• エントリと異なるインタフェースで受信したフレームの MAC アドレスを学習し、元のエントリを上書きします。 • エントリと同じインタフェースで受信したフレームを転送し、エントリのエージングタイマを更新します。

3.3.2. グローバルでのスタティック/ダイナミック MAC アドレスエントリの追加

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. スタティック/ダイナミック MAC アドレスエントリを追加する	**mac-address-table static** *mac-addr* **vlan** *vlan-id* { **interface** *interface-list* | **drop** }	デフォルト : グローバルで設定されたMACアドレスエントリはありません。

3.4. MACアドレス学習の無効化

MAC アドレス学習はデフォルトで有効です。装置が攻撃者から攻撃をうけたとき、MAC アドレステーブルが満たされないようにするため、MAC アドレスの学習を無効にします。たとえば、攻撃者からの異なる送信元 MAC アドレスの大量のフレームを学習しないように装置で MAC アドレスの学習を無効にすることができます。。

3.4.1. グローバルでの MAC アドレス学習の無効化

以下にグローバル MAC アドレス学習の無効化の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. グローバル MAC アドレス学習を無効にする	**undo mac-address-table learning interface** { **vlan** *vlan-id-list* | *interface-list* }	デフォルト : 有効

3.4.2. VLAN での MAC アドレス学習の無効化

グローバル MAC アドレス学習が有効であるとき、VLAN ごとに MAC アドレス学習を無効にすることができます。

以下に VLAN での MAC アドレス学習の無効化の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. VLAN で MAC アドレス学習を無効にする	**undo mac-address-table learning interface vlan** *vlan-id-list*	デフォルト：有効

3.5. ダイナミックMACアドレスエントリのエージングタイマの設定

装置の MAC アドレステーブルには、セキュリティとダイナミックエントリのリソースの浪費を防ぐために、エージングタイマがあります。もしエージングタイマが満了する前にダイナミック MAC アドレスエントリのアップデートが行われないと、装置はエントリを削除します。エージング機能は、MAC アドレステーブルを、最新のネットワークトポロジの変化に対応して即座にアップデートするためのものです。

トポロジの変更が少ない安定したネットワークではエージングタイマを長い時間にする必要があり、トポロジの変更が多いネットワークではエージングタイマを短い時間にする必要があります。

エージング間隔が長いと、有効期限切れのエントリを MAC アドレステーブルに残す可能性があります。MAC アドレステーブルリソースが枯渇する可能性があります。MAC アドレステーブルは最新のネットワーク変更に対応するためにエントリを更新できない場合があります。

エージング間隔が短いと、有効なエントリを削除してしまい、装置のパフォーマンスに影響を及ぼす不要なブロードキャストを送信する結果になる可能性があります。

不必要なエージングアウトからダイナミックエントリを防ぐために、エージングタイマの設定を長くするあるいはエージングタイマを無効にすることで安定したネットワークのブロードキャストを削減することができます。ネットワークのパフォーマンスを向上するだけでなく、思いがけない宛先にデータフレームを送信することを減らすことができるため、セキュリティも改善することができます。

以下にダイナミック MAC アドレスエントリのエージングタイマの設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. ダイナミック MAC アドレスエントリのエージングタイマを設定する	**mac-address-table aging-time** *seconds* **undo mac-address-table aging-time**	デフォルト：300秒 **undo**はエージングタイマを無効にします。

3.6. MACアドレステーブルの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
MACアドレステーブル情報を表示する	**display mac-address-table** [**dynamic** | **static**] [**address** *mac-addr* | **interface** *interface-id* | **vlan** *vlan-id*]

操作	コマンド
ダイナミックMACアドレスエントリのエージングタイマを表示する.	**display mac-address-table aging-time**
インタフェースのMACアドレス学習状態を表示する	**display mac-address-table learning interface** [**vlan** [*vlan-id-list*] | *interface-list*]

3.7. MACアドレステーブルの設定例

3.7.1. MAC アドレステーブルの設定例

I. ネットワーク要件

図 3-1 に示すように設定します。

- Host A （000f-e235-dc71）は、Device のインタフェース multi-GigabitEthernet 1/0/1 に接続され、VLAN1 に属しています。
- ネットワークで一度疑わしいふるまいをした Host B (000f-e235-abcd)は VLAN1 に属しています。

MAC アドレステーブルの設定を以下に示します。

- MAC アドレス spoofing を防ぐため、Device の MAC アドレステーブルの Host A にスタティックエントリを追加します。
- Host B 宛ての全フレームを破棄するため、Host B の MAC アドレスに対するドロップエントリを追加します。
- ダイナミック MAC アドレスエントリのエージングタイマを 500 秒に設定します。

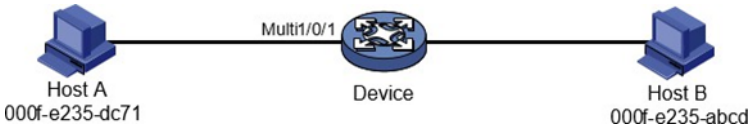

図 3-1 ネットワーク図

II. 設定手順

VLAN1 に属するインタフェース Multi-GigabitEthernet 1/0/1 に、MAC アドレス 000f-e235-dc71 のスタティック MAC アドレスエントリを追加します。

```
<Switch> system-view
[Switch] mac-address static 000f-e235-dc71 vlan 1 interface multi-GigabitEthernet 1/0/1
```

VLAN1 に属する MAC アドレス 000f-e235-abcd のドロップ MAC アドレスエントリを追加します。

```
[Switch] mac-address-table static 000f-e235-abcd vlan 1 drop
```

ダイナミック MAC アドレスエントリのエージングタイマを 500 秒に設定します。

```
[Switch] mac-address-table aging-time 500
```

III. 設定の確認

Multi-GigabitEthernet 1/0/1 のスタティック MAC アドレスエントリを表示します。

```
<Switch> display mac-address-table static interface multi-GigabitEthernet 1/0/1

VLAN MAC Address Type Ports
---- ----------------- ---------- -------------------------
1 00-0F-E2-35-DC-71 Static multi1/0/1

Total Entries: 1
<Switch>
```

MAC アドレスエントリを表示します。

```
<Switch> display mac-address-table static

VLAN MAC Address Type Ports
---- ----------------- ---------- -------------------------
1 00-11-78-90-CD-FF Static CPU
1 00-0F-E2-35-AB-CD Static Drop
1 00-0F-E2-35-DC-71 Static multi1/0/1

Total Entries: 3
<Switch>
```

ダイナミック MAC アドレスエントリのエージングタイムを表示します。

```
<Switch> display mac-address-table aging-time

Aging Time is 500 seconds.

<Switch>
```

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4章　リンクアグリゲーション

4.1. 概要

リンクアグリゲーションは、複数の物理的な Ethernet インタフェースを 1 つの論理的なリンクに集約します。

リンクアグリゲーションは以下の利点があります。

- アグリゲーショングループのメンバポートにトラフィックを分配することによって帯域を増やすことができます。
- アグリゲーショングループのメンバポートがお互いをダイナミックにバックアップすることで、接続信頼性を高めることができます。メンバポートが故障したとき、自動的に他のメンバポートに切り替えられます。

図 4-1 に示すように、Device A と Device B は 3 つの物理的な Ethernet リンクによって接続されています。これらの 3 つのインタフェースは、論理的なリンクアグリゲーション 1 と呼ばれるアグリゲートリンクに集約されています。リンクアグリゲーションの帯域幅は、3 つの物理的な Ethernet インタフェースの合計の帯域幅と同一となります。同時に 3 つの Ethernet インタフェースは、それぞれ別のリンクをバックアップします。物理的な Ethernet リンク が障害を起こした場合、障害リンクで送信されていたトラフィックは他の 2 本のリンクに切り替わります。

図 4-1 リンクアグリゲーション図

4.1.1. アグリゲーショングループ、メンバポート、アグリゲートインタフェース

アグリゲーショングループは、集約された Ethernet インタフェースのグループです。各アグリゲートインタフェースには自動的に作成されるアグリゲーショングループがあり、アグリゲーションに使用するメンバポートが含まれます。アグリゲーショングループのタイプと番号は、アグリゲートインタフェースと同じです。

アグリゲートインタフェースは、以下のタイプがあります。

- **レイヤ 2** – アグリゲートインタフェースは手動で作成されます。アグリゲーショングループのメンバポートはレイヤ 2 Ethernet インタフェースでのみ設定できます。

アグリゲートインタフェースのレートは、Selected ステートのそのメンバポートのレートの合計と同一です。また通信モードは Selected ステートのメンバポートと同一です。

4.1.2. アグリゲーショングループのメンバポートのステート

アグリゲーショングループのメンバポートは、以下のステートのどちらかとなります。

- **Selected** – ユーザにトラフィックを送受信できます。
- **Unselected** – ユーザにトラフィックを送受信できません。
- **Individual** – Individual ポートは通常の物理インタフェースとしてトラフィックを転送することができます。以下の状態の場合、ポートは Individual 状態となります。
  - 対応するアグリゲートインタフェースがエッジアグリゲートインタフェースとして設定されています。
  - ポートがピアポートから LACPDU（Link Aggregation Control Protocol Data Units）を受信していません。

4.1.3. オペレーショナルキー

ポートを集約する際に、リンクアグリケーションは、ポートレート、通信モードのような設定を含むポート属性にもとづいてオペレーショナルキーをそれぞれのポートに自動的に制御し、割り当てます。この情報の変更があると、オペレーショナルキーの再計算がトリガされます。

リンクアグリゲーショングループ内にある Selected ステートのすべてのメンバポートは、同じオペレーショナルキーを持っています。

4.1.4. コンフィグレーションタイプ

ポート設定には、属性設定とプロトコル設定が含まれます。リンクアグリゲーションメンバポートの属性設定は、そのアグリゲーション状態に影響を与えます。

- **属性コンフィグレーション**– Selected ポートになるためには、メンバポートはアグリゲートインタフェースとして同じ属性の設定を持つ必要があります。表 4-1 に属性コンフィグレーションを示します。

  アグリゲートインタフェースで行われた属性コンフィグレーションの変更は、すべてのメンバポートに自動的に同期されます。変更が Selected ポートへの同期に失敗した場合、そのポートは Unselected ポートに変わる可能性があります。ポートを再度 Selected ポートにするには、アグリゲートインタフェースまたはメンバポートで属性コンフィグレーションを変更できます。 同期の失敗は、アグリゲートインタフェースで行われた属性コンフィグレーションの変更には影響しません。アグリゲートインタフェースから同期された設定は、アグリゲートインタフェースが削除された後もメンバポートに保持されます。

  属性コンフィグレーションの変更は、リンクアグリゲーションメンバポートのアグリゲーションのステートと動作中のサービスに影響する可能性があります。この影響を確認するため、システムは、メンバポートの属性設定を変更するごとに警告メッセージを表示します。

表 4-1 属性設定

機能	属性コンフィグレーション
Port isolation	solationグループへのポートの加入状態。 現在のソフトウェアではPort isolationをサポートしていません。
VLAN	VLAN属性の設定は以下があります。 • 許可された VLAN ID

機能	属性コンフィグレーション
	• PVID • リンクタイプ(trunk、hybrid、access) • 動作モード（promiscuous、トランク promiscuous、ホスト、トランクセカンダリ) • VLAN タグモード VLANについては、オペレーションマニュアルのセクション2 *アクセス "VLAN"*を参照してください。

- **プロトコルコンフィグレーション** – プロトコルコンフィグレーションは、アグリゲートインタフェースの変更があってもメンバポートのアグリゲートステートに影響しません。プロトコルコンフィグレーションの例として、MAC アドレス学習と、スパニングツリーがあります。

  現在のソフトウェアでは STP をサポートしていません。

メモ:

- アグリゲートインタフェースのプロトコルコンフィグレーションは、カレントアグリゲートインタフェースでのみ有効になります。
- メンバポートのプロトコルコンフィグレーションは、ポートがアグリゲーショングループから削除されるまで適用されません。

4.1.5. リンクアグリゲーションモード

リンクアグリゲーションは、ダイナミックモードとスタティックモードがあります。

- **スタティック** – アグリゲーションが安定します。スタティックモードのアグリゲーショングループは、スタティックアグリゲーショングループと呼ばれます。メンバポートのアグリゲーションステートは対向先の影響を受けません。
- **ダイナミック** – ダイナミックモードのアグリゲーショングループは、ダイナミックアグリゲーショングループと呼ばれます。ローカルシステムと対向先のシステムはメンバポートのアグリゲーションステートを自動的に管理します。管理者の管理負荷を削減することができます。

4.1.6. スタティックリンクアグリゲーションの動作

I. リファレンスポートの選出

アグリゲーショングループでポートのアグリゲーションステートを設定するとき、システムはリファレンスポートとして自動でメンバポートを選出します。Selected ポートはリファレンスポートとして、同じオペレーショナルキーと属性コンフィグレーションを持つ必要があります。

メンバポートから、アグリゲートインタフェースとして同一の属性を持つ up 状態のリファレンスポートを選択します。

候補となるポートの優先順位は、以下の順番となります。

1. もっとも高いポート優先度
2. 全 2 重/高速
3. 全 2 重/低速
4. 半 2 重/高速
5. 半 2 重/低速

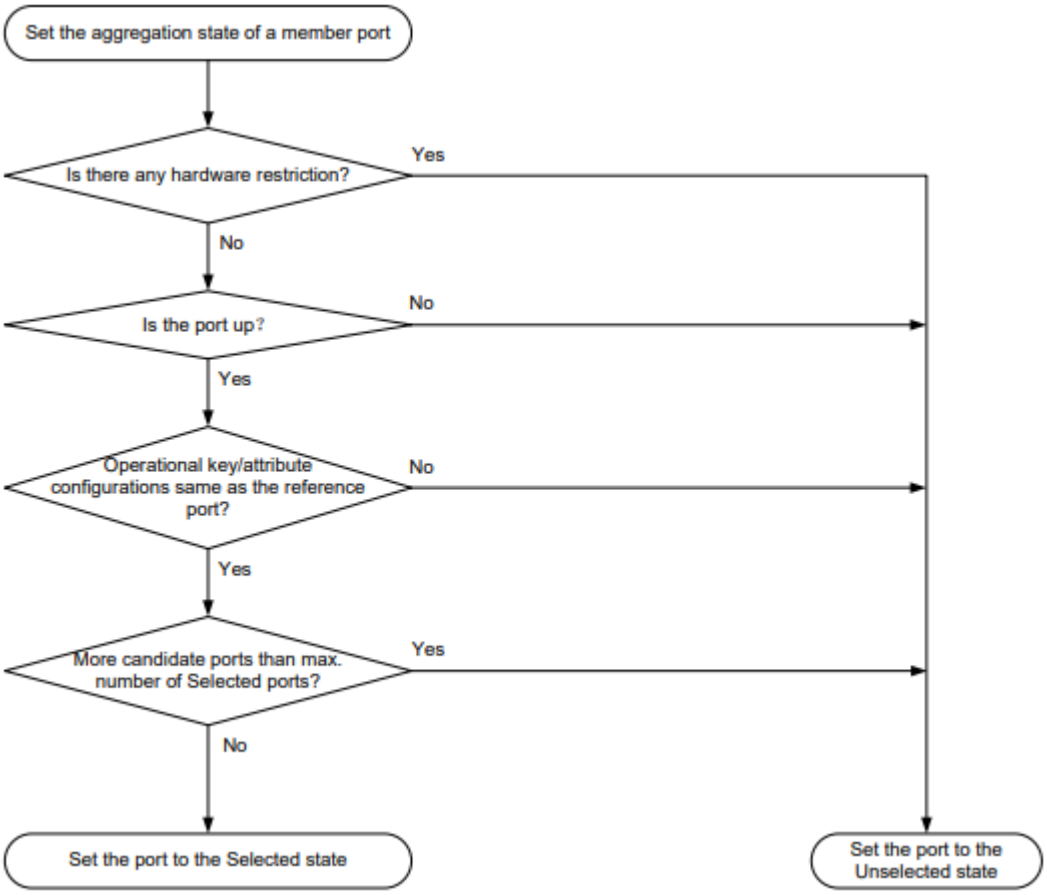
アグリゲートインタフェースと同じ属性コンフィグレーションを持つ候補のポートから、もっとも高い優先度レベルを持つポートがリファレンスポートとして選択されます。

- 同じ優先度を持つポートが複数あり、Selected ポートがある場合、Selected ポートが選ばれます。もし 1 つ以上の最初の Selected ポートがある場合、ポート番号が一番小さい Selected ポートが選択されます。
- 複数のポートに同じ優先度があり、Selected ポートがない場合、ポート番号が一番小さい Selected ポートが選択されます。

II. 各メンバポートのアグリゲーションステートの設定

リファレンスポートを選択すると、システムはスタティックアグリゲーショングループ内の各メンバートのアグリゲーションステートを設定します。

III. スタティックアグリゲーショングループのアグリゲーションステートの設定



Selected ポートの制限に到達したのち、新しいメンバポートのアグリゲーションの状態は以下の状態によって変わります。

- ポートと Selected ポートが同一の優先度を持つ場合、ポートは Unselected ステートに遷移します。このメカニズムによって既存の Selected ポートでトラフィックの中断を防ぎます。装置の再起動を行うとメンバポートのアグリゲーションステートの再計算が行われます。
- 以下の状態の場合、ポートは Selected ステートに遷移します。

- ポートと Selected ポートが異なる優先度を持つ場合、ポートは少なくとも 1 つの Selected ポートの優先度よりも高い優先度を持ちます。
- アグリゲートインタフェースとして同一の属性コンフィグレーションを持ちます。

オペレーショナルキーと属性コンフィグレーションを変更すると、リンクアグリゲーションメンバポートのアグリゲーションの状態に影響を及ぼす可能性があります。

4.1.7. LACP

ダイナミックアグリゲーションモードは、IEEE 802.3ad Link Aggregation Control Protocol（LACP）で規定されています。

LACP は LACP 対応装置と LACPDU（Link Aggregation Control Protocol Data Units）を使用し、情報交換を行います。LACP が有効なアグリゲーショングループのメンバポートは、対向先と情報の交換を行います。メンバポートが LACPDU を受信すると、ほかのメンバポートで受信された情報と受信された情報を比較します。比較することで、2 つのシステム間で Selected ステートになるポートを選定します。

I. LACP の機能

表 4-2 は基本 LACP 機能を示します。

表 4-2 基本 LACP 機能

カテゴリ	説明
基本LACP機能	システムLACPプライオリティ、システムMACアドレス、ポートLACPプライオリティ、ポート番号、オペレーショナルキーを含む基本的なLACPDUフィールドから実装されます。

II. LACP 動作モード

LACP はアクティブモードあるいはパッシブモードで動作することができます。

LACP がローカルメンバポートとピアのポート上でパッシブモードとして動作するとき、双方のポートは LACPDU を送信することができません。LACP がローカルメンバポートとピアのポート上でアクティブモードとして動作するとき、双方のポートは LACPDU を送信することができます。

III. LACP プライオリティ

表 4-3 に示すように LACP プライオリティには、システム LACP プライオリティとポートプライオリティの 2 種類があります。値が小さいほどプライオリティが高くなります。

表 4-3 LACP プライオリティ

タイプ	説明
システムLACPプライオリティ	リンクアグリゲーションで優勢な装置かを決定するために2つの対向装置（あるいはシステム）で使用します。 ダイナミックリンクアグリゲーションでより高いシステムLACPプライオリティを持つ2つの対向装置（あるいはシステム）がメンバポートのSelectedステートになるポートを設定します。 低いプライオリティを持つシステムはそれぞれの対向先のポートと同様にローカルメンバポートのアグリゲーションステートを設定します。
ポートプライオリティ	システムで選択されるために、メンバポートのプライオリティが決められます。

タイプ	説明
	より高いポートプライオリティを持つメンバポートがSelectedステートになります。

IV. LACP タイムアウト間隔

LACP タイムアウト間隔は、メンバポートが対向のポートから LACPDU を受信するための待ち時間です。もしローカルメンバポートが、LACP タイムアウト間隔時間以内に対向先から LACPDU を受信できない場合、メンバポートは対向先が故障していると認識します。

LACP タイムアウト間隔は、対向先の LACPDU 送信レートも決まります。LACP タイムアウト間隔は以下のタイプを含みます。

- **短いタイムアウト間隔** – タイムアウト間隔は 3 秒です。短いタイムアウト間隔を設定した場合、ピアは 1 秒に 1 回の LACPDU を送信します。
- **長いタイムアウト間隔** –長いタイムアウト間隔は 90 秒です。長いタイムアウト間隔を設定した場合、ピアは 30 秒ごとに 1 つの LACPDU を送信します。

4.1.8. ダイナミックリンクアグリゲーションの動作

I. リファレンスポートの選出

システムは up 状態のメンバポートからリファレンスポートを選択します。Selected ポートはリファレンスポートと同じオペレーショナルキーと属性コンフィグレーションを持つ必要があります。

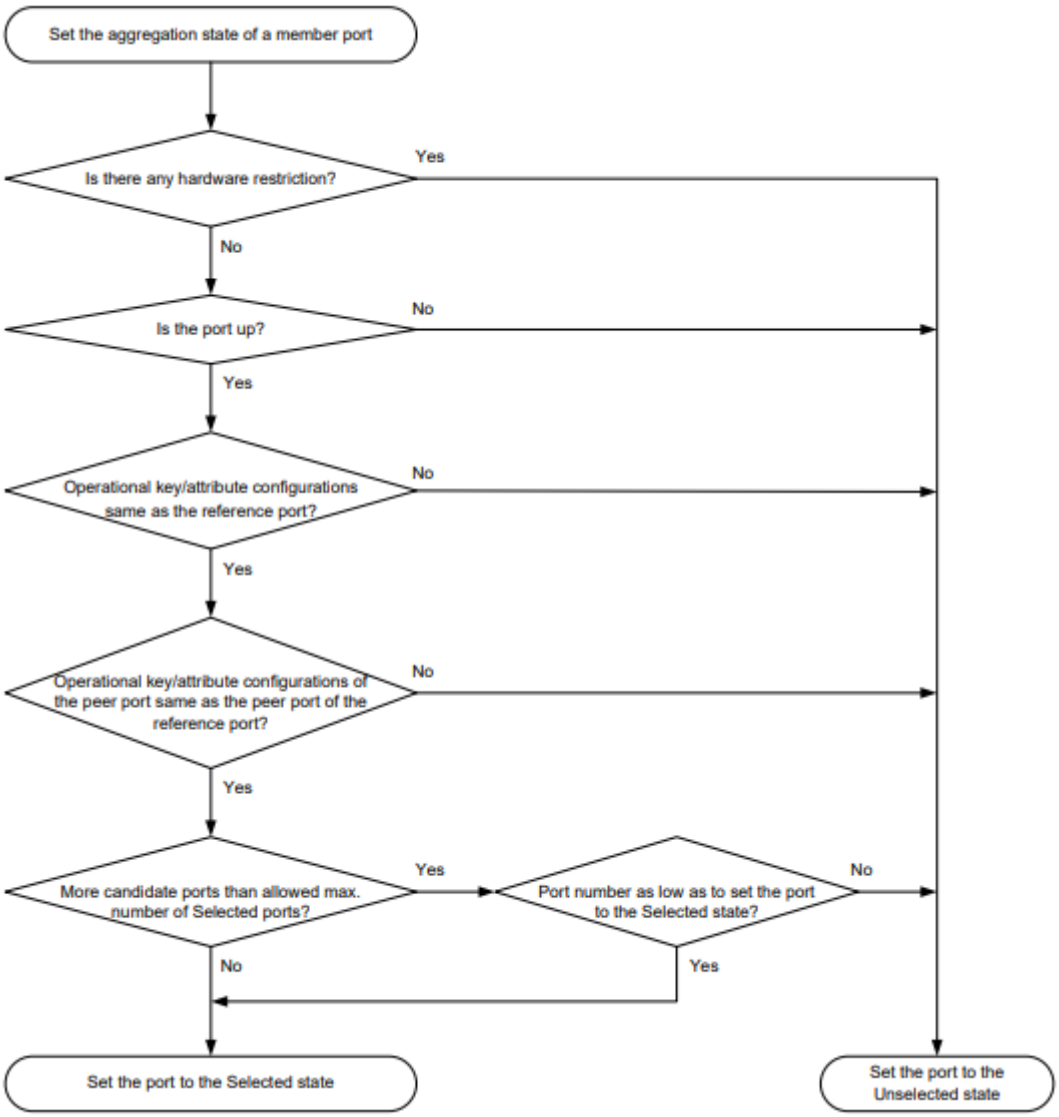
ローカルシステムは、リファレンスポートを選出するために、リモートシステムと以下の手順が行われます。

1. ローカルシステムのシステム ID をリモートシステムのシステム ID と比較します。システム ID はシステム LACP プライオリティと MAC アドレスが含まれます。
   a. LACP 優先度値を比較します。
      LACP プライオリティが低いほど、システム ID は小さくなります。LACP プライオリティの値が同じ場合、2 つのシステムは手順 b に進みます。
   b. MAC アドレスを比較します。
      MAC アドレスが小さいほど、システム ID は小さくなります。
2. 小さいシステム ID のシステムはリファレンスポートとして最も小さいポート ID のポートが選出されます。
   ポート ID はポート LACP プライオリティとポート番号から構成されます。ポートプライオリティが低いほど、ポート ID は小さくなります。
   a. システムはリファレンスポートとして最も小さいプライオリティのポートが選出されます。同じポート LACP プライオリティを持つ場合、システムは手順 b に進みます。
   b. システムはポート番号を比較します。
      ポート番号が小さいほど、ポート ID も小さくなります。
      最も小さい値のポートと、アグリゲートインタフェースと同一の属性コンフィグレーションを持つポートはリファレンスポートとして選出されます。

II. メンバポートのアグリゲーションステートの設定

リファレンスポートを選出した後、ダイナミックアグリゲーショングループは、個々のメンバポートのアグリゲーションステートを設定します。

III. ダイナミックアグリゲーショングループのアグリゲーションステートの設定



高いシステム ID を持つシステムが、リモートシステムのステート状態を認識しています。システムは対向先のポートと同じようにローカルメンバポートのアグリゲーションステートを設定します。

ダイナミックモードでアグリゲートインタフェースを設定するとき、以下のガイドラインに従ってください。

- ダイナミックリンクアグリゲーショングループは、Selected ポートとして全 2 重のみ選択します。
- 安定的なアグリゲーションステートやサービスを中断させないため、メンバポートのオペレーショナルキーや属性コンフィグレーションを変更しないでください。
- Selected ポートが制限に達した後、現在のメンバポートよりも適したポートである場合、ダイナミックアグリゲーショングループに追加されたポートは、Selected ポートになります。

4.1.9. エッジアグリゲートインタフェース

ダイナミックリンクアグリゲーションがデバイス上でのみ構成されている場合、ダイナミックリンクアグリゲーションはサーバ向きのアグリゲートインタフェースで失敗します。装置は、サーバに接続されている物理ポートの 1 つだけを使用してトラフィックを転送します。

リンクの信頼性を向上させるには、アグリゲートインタフェースをエッジアグリゲートインタフェースとして構成します。この機能により、アグリゲーショングループのすべてのメンバポートがトラフィックを転送できます。メンバポートに障害が発生すると、そのトラフィックは自動的に他のメンバポートに切り替えられます。

ダイナミックリンクアグリゲーションがサーバ上で構成された後、装置はサーバから LACPDU を受信できます。 その後、装置とサーバ間のリンクアグリゲーションが正しく動作します。

エッジアグリゲートインタフェースは、ダイナミックアグリゲーショングループに対応するアグリゲートインタフェース上で構成されている場合にのみ有効です。

4.1.10. リンクアグリゲーショングループの負荷分散

リンクアグリゲーショングループにおいて、トラフィックは、Selected メンバポートを通り、以下のモードにもとづいて負荷分散が行われます。

- **フローベース負荷分散** – トラフィックはフローごとに負荷分散されます。負荷分散のモードはパケットをフローで分類し、同じリンクの同一のフローのパケットを転送します。このモードは以下の基準またはその組み合わせによってトラフィックフローを分類することができます。
  - 入力ポート
  - 送信元あるいは宛先 IP アドレス
  - 送信元あるいは宛先 MAC アドレス
  - 送信元あるいは宛先ポート番号
- **パケットベース負荷分散** – 自動的にパケットタイプ(例 レイヤ 2、IPv4、IPv6)のリンクアグリゲーション負荷分散を選択します。

4.2. リンクアグリゲーション設定作業リスト

作業リスト
(必須設定項目) アグリゲーショングループの設定 • レイヤ 2 アグリゲーショングループの設定
(オプション設定項目) アグリゲートインタフェースの設定 • アグリゲートインタフェースの説明の設定
(オプション設定項目)リンクアグリゲーショングループの負荷分散の設定 • リンクアグリゲーショングループの負荷分散モードの設定

4.3. アグリゲーショングループの設定

この章では、アグリゲーショングループの設定方法について説明します。

4.3.1. 制限とガイドライン

I. アグリゲーションメンバインタフェースの制限

- インタフェースに表 4-4 のいずれかの機能が設定されている場合、そのインタフェースをレイヤ 2 アグリゲーション グループに割り当てることはできません。

表 4-4 レイヤ 2 アグリゲーション メンバインタフェースと互換性のない機能

インタフェース機能	参照
MACアドレス認証	現在のソフトウェアではMACアドレス認証をサポートしていません。
802.1X	現在のソフトウェアでは802.1X認証をサポートしていません。

II. 設定の整合性の要件

- アグリゲーションリンクのエンド間に同じアグリゲーションモードを設定する必要があります。
- スタティックアグリゲーションを正常に動作させるには、各アグリゲーションリンクポートの両端に同じアグリゲーションステートを設定する必要があります。
- ダイナミックアグリゲーションを正常に動作させるには、装置と対向装置でポートがアグリゲートされていることを確認してください。2 つのエンド間で、各メンバポートのアグリゲーションステートを自動的に処理することができます。

III. その他

アグリゲートインタフェースを削除する場合、アグリゲーショングループを削除し、アグリゲーショングループからすべてのメンバポートを削除してください。

4.3.2. レイヤ 2 アグリゲーショングループの設定

I. レイヤ 2 スタティックアグリゲーショングループの設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. 指定されたレイヤ 2 アグリゲーショングループにインタフェースを割り当てる	Layer 2 Ethernet interface Viewに移行する: **interface** *interface-id* 指定されたレイヤ2アグリゲーショングループにインタフェースをスタティックメンバとして割り当てる **channel-group** *channel-no* **mode on**	アグリゲーショングループに複数のインタフェースを割り当てる場合、このステップを繰り返してください。
3. (オプション) インタフェースのポートプライオリティ設定する	**lacp port-priority** *priority*	デフォルト：32768

II. レイヤ 2 ダイナミックアグリゲーショングループの設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. システム LACP プライオリティを設定する	**lacp system-priority** *priority*	デフォルト：32768 システム LACP プライオリティを変更すると、ダイナミックアグリゲーショングループ内のポートの集約状態に影響する可能性があります。
3. 指定したレイヤ 2 アグリゲーショングループにインタフェースを割り当てる	Layer 2 Ethernet interface view に移行する **interface** *interface-id* 指定されたレイヤ2アグリゲーショングループにインタフェースをダイナミックメンバとして割り当てる **channel-group** *channel-no* **mode** { **active** | **passive** }	アグリゲーショングループに複数のインタフェースを割り当てる場合、このステップを繰り返してください。
4. インタフェースのポートプライオリティを設定する	**lacp port-priority** *priority*	デフォルト：32768
5. インタフェースに短い LACP タイムアウト間隔 (3 秒)を設定する	**lacp timeout short**	デフォルト：3秒

4.4. アグリゲートインタフェースの設定

レイヤ 2 またはレイヤ 3 イーサネットインタフェースで実行できる設定のほとんどは、レイヤ 2 またはレイヤ 3 アグリゲートインタフェースでも実行できます。

4.4.1. アグリゲートインタフェースの説明の設定

インタフェースの目的などを記載するように、管理者用にアグリゲートインタフェースの説明を記載することができます。

以下にアグリゲートインタフェースの説明の設定する方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. aggregate interface view または subinterface view に移行する	**interface bridge-aggregation** *interface-number*	—

操作	コマンド	補足
3. アグリゲートインタフェースまたはサブインタフェースの説明を設定する	**description** *string*	デフォルト：設定なし

4.5. リンクアグリゲーショングループの負荷分散の設定

この章では、リンクアグリゲーショングループの負荷分散モードの設定方法について説明します。

4.5.1. リンクアグリゲーショングループの負荷分散モードの設定

I. グローバルリンクアグリゲーション負荷分散モードの設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. グローバルリンクアグリゲーション負荷分散モードを設定する	**bridge-aggregation load-balance { dst-ip | dst-mac | src-dst-ip | src-dst-mac | src-ip | src-mac | dst-l4-port | src-dst-l4-port | src-l4-port }**	デフォルト : パケットタイプによって自動的にグローバルでのロードシェアリングモードが選択されます。

4.5.2. リンクアグリゲーションの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
アグリゲートインタフェースまたは複数のアグリゲートインタフェースの情報を表示する	**display interfaces [bridge-aggregation** { *interface-number* } **] [description]**
ローカルシステムIDを表示する	**display channel-group sys-id**
グローバルリンクアグリゲーションの負荷分散モードを表示する	**display channel-group load-balance**
すべてのアグリゲーショングループの概要情報を表示する	**display channel-group**
指定されたアグリゲーショングループの詳細情報を表示する	**display channel-group [channel [** *channel-no* **] { detail | neighbor }]**

4.6. リンクアグリゲーションの設定例

4.6.1. レイヤ 2 スタティックアグリゲーションの設定例

I. ネットワーク要件

図 4-2 に示すように以下の要件を設定します。

- Device A と Device B の両方でレイヤ 2 スタティックアグリゲーショングループを設定します。
- 片端で VLAN10 を有効にし、VLAN10 でアグリゲートリンクの対向先と通信します。
- 片端で VLAN20 を有効にし、VLAN20 でアグリゲートリンクの対向先と通信します。

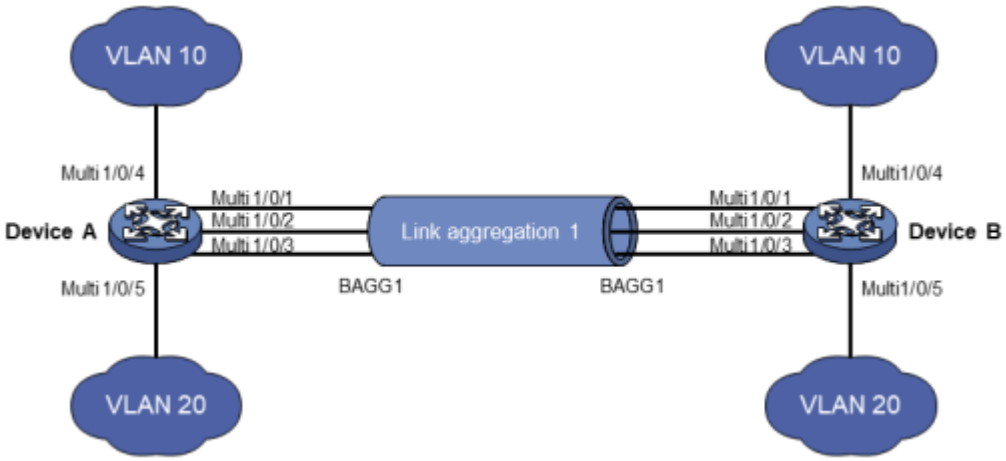


図 4-2 ネットワーク図

II. 設定手順

1. Device A を設定します。

VLAN10 を作成し、Multi-GigabitEthernet 1/0/4 を VLAN10 に割り当てます。

```
<SwitchA> system-view
[SwitchA] vlan 10
[SwitchA-vlan10] quit
[SwitchA] interface Multi-GigabitEthernet 1/0/4
[SwitchA-Multi-GigabitEthernet1/0/4] port link-type hybrid
[SwitchA-Multi-GigabitEthernet1/0/4] switchport hybrid allowed vlan add untagged 10
[SwitchA-Multi-GigabitEthernet1/0/4] quit
```

VLAN20 を作成し、Multi-GigabitEthernet 1/0/5 を VLAN20 に割り当てます。

```
[SwitchA] vlan 20
[SwitchA-vlan20] quit
[SwitchA] interface Multi-GigabitEthernet 1/0/5
[SwitchA-Multi-GigabitEthernet1/0/5] port link-type hybrid
[SwitchA-Multi-GigabitEthernet1/0/5] switchport hybrid allowed vlan add untagged 20
[SwitchA-Multi-GigabitEthernet1/0/5] quit
```

Multi-GigabitEthernet 1/0/1～1/0/3 ポートにリンクアグリゲーショングループ 1 を割り当てます。

```
[SwitchA] interface range Multi-GigabitEthernet 1/0/1 to Multi-GigabitEthernet 1/0/3
[SwitchA-if-range] channel-group 1 mode on
[SwitchA-if-range] quit
```

Bridge-Aggregation 1 をトランクポートとして作成し、VLAN10 および 20 に割り当てます。

```
[SwitchA] interface bridge-aggregation 1
[SwitchA-Bridge-Aggregation1] port link-type trunk
[SwitchA-Bridge-Aggregation1] port trunk permit vlan 10 20
[SwitchA-Bridge-Aggregation1] return
```

2. Device A の設定と同様に Device B を設定します。(詳細は省略します。)

III. 設定の確認

Device A 上のすべてのアグリゲーショングループの詳細情報を表示します。

```
<SwitchA> display channel-group channel detail
Flag:
 S - Port is requesting Slow LACPDUs F - Port is requesting fast LACPDU
 A - Port is in active mode P - Port is in passive mode
LACP state:
 bndl: Port is attached to an aggregator and bundled with other ports.
 hot-sby: Port is in a hot-standby state.
 down: Port is down.
Channel Group 1
 Member Ports: 3, Maxports = 8, Protocol: Static
 LACP Port Port
 Port Flags State Priority Number
 ------------------------------------------------
 multi1/0/1 N/A bndl N/A N/A
 multi1/0/2 N/A bndl N/A N/A
 multi1/0/3 N/A bndl N/A N/A
<SwitchA>
```

出力では、リンクアグリゲーショングループ 1 が 3 つの Selected ポートを含むレイヤ 2 スタティックアグリゲーショングループであることを示しています。

4.6.2. レイヤ 2 ダイナミックアグリゲーションの設定例

I. ネットワーク要件

図 4-3 に示すように以下の要件を設定します。

- Device A と Device B の両方でレイヤ 2 ダイナミックアグリゲーショングループを設定します。
- 片端で VLAN10 を有効にし、VLAN10 でアグリゲートリンクの対向先と通信します。
- 片端で VLAN20 を有効にし、VLAN20 でアグリゲートリンクの対向先と通信します。

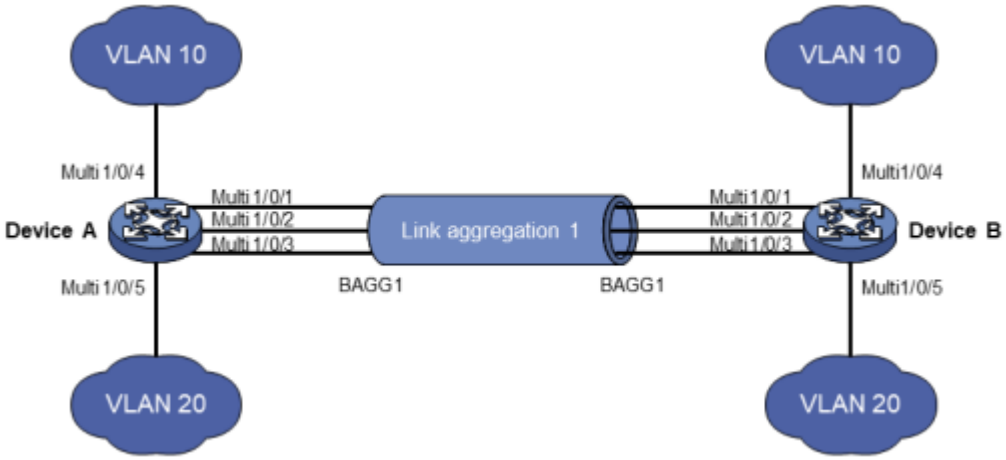


図 4-3 ネットワーク図

II. 設定手順

1. Device A を設定します。

VLAN10 を作成し、Multi-GigabitEthernet 1/0/4 を VLAN10 に割り当てます。

```
<SwitchA> system-view
[SwitchA] vlan 10
[SwitchA-vlan10] quit
[SwitchA] interface Multi-GigabitEthernet 1/0/4
[SwitchA-Multi-GigabitEthernet1/0/4] port link-type hybrid
[SwitchA-Multi-GigabitEthernet1/0/4] switchport hybrid allowed vlan add untagged 10
[SwitchA-Multi-GigabitEthernet1/0/4] quit
```

VLAN20 を作成し、Multi-GigabitEthernet 1/0/5 を VLAN20 に割り当てます。

```
[SwitchA] vlan 20
[SwitchA-vlan20] quit
[SwitchA] interface Multi-GigabitEthernet 1/0/5
[SwitchA-Multi-GigabitEthernet1/0/5] port link-type hybrid
[SwitchA-Multi-GigabitEthernet1/0/5] switchport hybrid allowed vlan add untagged 20
[SwitchA-Multi-GigabitEthernet1/0/5] quit
```

Multi-GigabitEthernet 1/0/1～1/0/3 にリンクアグリゲーショングループ 1 を割り当てます。

```
[SwitchA] interface range Multi-GigabitEthernet 1/0/1 to Multi-GigabitEthernet 1/0/3
[SwitchA-if-range] channel-group 1 mode active
[SwitchA-if-range] quit
```

Bridge-Aggregation 1 をトランクポートとして作成し、VLAN10 および 20 に割り当てます。

```
[SwitchA] interface bridge-aggregation 1
[SwitchA-Bridge-Aggregation1] port link-type trunk
[SwitchA-Bridge-Aggregation1] port trunk permit vlan 10 20
[SwitchA-Bridge-Aggregation1] return
```

2. Device A の設定と同様に Device B を設定します。(詳細は省略します。)

III. 設定の確認

DeviceA 上の全てのアグリゲーショングループの詳細情報を表示します。

```
<SwitchA> display channel-group channel detail
Flag:
 S - Port is requesting Slow LACPDUs F - Port is requesting fast LACPDU
 A - Port is in active mode P - Port is in passive mode
LACP state:
 bndl: Port is attached to an aggregator and bundled with other ports.
 hot-sby: Port is in a hot-standby state.
 down: Port is down.
Channel Group 1
 Member Ports: 3, Maxports = 8, Protocol: LACP
 LACP Port Port
 Port Flags State Priority Number
 ---------------------------------------------------
 multi1/0/1 FA bndl 32768 1
 multi1/0/2 FA bndl 32768 2
 multi1/0/3 FA bndl 32768 3
<SwitchA>
```

出力では、リンクアグリゲーショングループ 1 が 3 つの選択ポートを含むレイヤ 2 ダイナミックアグリゲーショングループであることを示しています。

4.6.3. レイヤ 2 アグリゲーション負荷分散の設定例

I. ネットワーク要件

図 4-4 に示すように以下の要件を設定します。

- Device A および Device B で、それぞれレイヤ 2 スタティックアグリゲーショングループ 1 および 2 を設定します。
- 片端で VLAN10 を有効にし、VLAN10 でアグリゲートリンクの対向先と通信します。
- 片端で VLAN20 を有効にし、VLAN20 でアグリゲートリンクの対向先と通信します。
- リンクアグリゲーショングループ 1 および 2 を設定し、アグリゲーショングループのメンバポート間でトラフィックの負荷分散を行います。
    - 送信元 MAC アドレスに基づいてパケットの負荷分散を行うリンクアグリゲーショングループを設定します。

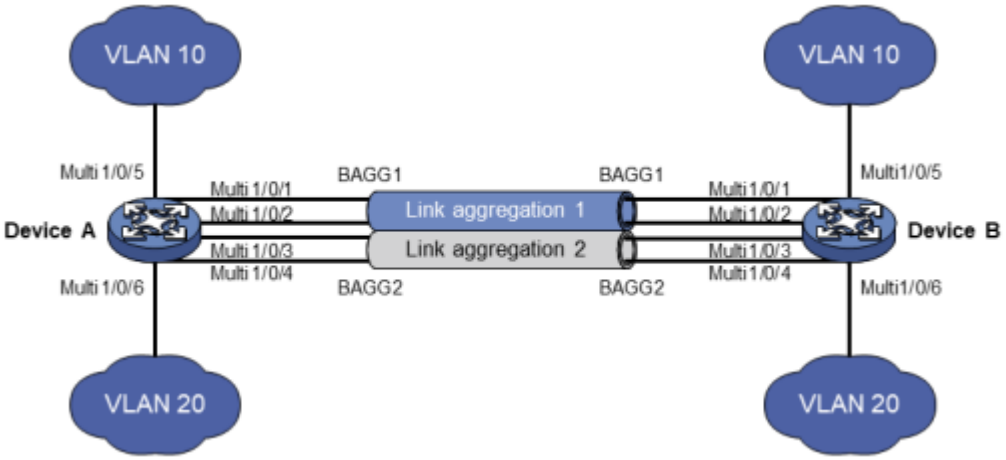


図 4-4 ネットワーク図

II. 設定手順

1. Device A を設定します。

VLAN10 を作成し、Multi-GigabitEthernet 1/0/5 を VLAN10 に割り当てます。

```
<SwitchA> system-view
[SwitchA] vlan 10
[SwitchA-vlan10] quit
[SwitchA] interface Multi-GigabitEthernet 1/0/5
[SwitchA-Multi-GigabitEthernet1/0/5] port link-type hybrid
[SwitchA-Multi-GigabitEthernet1/0/5] switchport hybrid allowed vlan add untagged 10
[SwitchA-Multi-GigabitEthernet1/0/5] quit
```

VLAN20 を作成し、Multi-GigabitEthernet 1/0/6 を VLAN20 に割り当てます。

```
[SwitchA] vlan 20
[SwitchA-vlan20] quit
[SwitchA] interface Multi-GigabitEthernet 1/0/6
[SwitchA-Multi-GigabitEthernet1/0/6] port link-type hybrid
[SwitchA-Multi-GigabitEthernet1/0/6] switchport hybrid allowed vlan add untagged 20
[SwitchA-Multi-GigabitEthernet1/0/6] quit
```

送信元 MAC アドレスに基づくパケット負荷分散を行うアグリゲーショングループ 1 を設定します。

```
[SwitchA] bridge-aggregation load-balance src-mac
```

ポート Multi-GigabitEthernet 1/0/1 および 1/0/2 をリンクアグリゲーショングループ 1 に割り当てます。

```
[SwitchA] interface range Multi-GigabitEthernet 1/0/1 to Multi-GigabitEthernet 1/0/2
[SwitchA-if-range] channel-group 1 mode on
[SwitchA-if-range] quit
```

Bridge-Aggregation 1 をトランクポートとして設定し、VLAN10 に割り当てます。

```
[SwitchA] interface bridge-aggregation 1
[SwitchA-Bridge-Aggregation1] port link-type trunk
[SwitchA-Bridge-Aggregation1] port trunk permit vlan 10
```

```
[SwitchA-Bridge-Aggregation1] quit
```

ポート Multi-GigabitEthernet 1/0/3 および 1/0/4 をリンクアグリゲーショングループ 2 に割り当てます。

```
[SwitchA] interface range Multi-GigabitEthernet 1/0/3 to Multi-GigabitEthernet 1/0/4
[SwitchA-if-range] channel-group 2 mode on
[SwitchA-if-range] quit
```

Bridge-Aggregation 2 をトランクポートとして設定し、VLAN20 に割り当てます。

```
[SwitchA] interface bridge-aggregation 2
[SwitchA-Bridge-Aggregation2] port link-type trunk
[SwitchA-Bridge-Aggregation2] port trunk permit vlan 20
[SwitchA-Bridge-Aggregation2] return
```

2. Device A の設定と同様に Device B を設定します。(詳細は省略します。)

III. 設定の確認

DeviceA 上の全てのアグリゲーショングループの詳細情報を表示します。

```
<SwitchA> display channel-group channel detail
Flag:
 S - Port is requesting Slow LACPDUs F - Port is requesting fast LACPDU
 A - Port is in active mode P - Port is in passive mode
LACP state:
 bndl: Port is attached to an aggregator and bundled with other ports.
 hot-sby: Port is in a hot-standby state.
 down: Port is down.
Channel Group 1
 Member Ports: 2, Maxports = 8, Protocol: Static
 LACP Port Port
 Port Flags State Priority Number
 ----------------------------------------------------
 multi1/0/1 N/A bndl N/A N/A
 multi1/0/2 N/A bndl N/A N/A
Channel Group 2
 Member Ports: 2, Maxports = 8, Protocol: Static
 LACP Port Port
 Port Flags State Priority Number
 ----------------------------------------------------
 multi1/0/3 N/A bndl N/A N/A
 multi1/0/4 N/A bndl N/A N/A
<SwitchA>
```

出力では以下のことを示します。

- リンクアグリゲーショングループ 1 および 2 は、負荷分散されたレイヤ 2 スタティックアグリゲーショングループです。
- 各アグリゲーショングループには 2 つの選択ポートが含まれています。

Device A 上のグループ固有の負荷分散モードをすべて表示します。

```
<SwitchA> display channel-group load-balance
load-balance algorithm: src-mac
<SwitchA>
```

出力では、リンクアグリゲーショングループ 1 が送信元 MAC アドレスに基づいてパケットの負荷分散を行っていることを示しています。

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5章 LLDP

5.1. 概要

異種混在ネットワークにおいて、標準的な設定交換プラットフォームは、異なるベンダの異なる種類のネットワーク装置が相互に検出され、設定を交換できるようにします。

リンク層検出プロトコル（LLDP）は IEEE 802.1AB で規定されています。このプロトコルはデータリンク層で動作し、直接接続された装置間で装置情報を交換します。LLDP では、装置はローカル装置情報を TLV（タイプ、長さ、値）の 3 要素で構成される LLDP データユニット（LLDPDU）として直接接続された装置に送信します。ローカル装置情報には、システム機能、管理用 IP アドレス、装置 ID、ポート ID などが含まれます。装置は、LLDP 隣接から受信した LLDPDU 内の装置情報を標準 MIB に保存します。LLDP により、ネットワーク管理システムはレイヤ 2 ネットワークトポロジの変更を迅速に検出・識別できます。

5.1.1. 基本概念

I. LLDP エージェント

LLDP エージェントとは、LLDP が動作するエンティティのマッピングです。同一インタフェース上で複数の LLDP エージェントを実行できます。

LLDP エージェントは以下のタイプに分類されます。

- Nearest bridge エージェント
- Nearest customer bridge エージェント
- Nearest non-TPMR bridge エージェント

Two-port MAC Relay（TPMR）は、外部からアクセス可能なブリッジポートが 2 つしかないタイプのブリッジです。MAC ブリッジの機能の一部をサポートします。TPMR は、以下のプロトコルを除き、すべてのフレームベースのメディア非依存プロトコルに対して透過的です。

- 自身宛てのプロトコル
- TPMR のリレー機能が転送しないように設定されている、予約済み MAC アドレス宛のプロトコル

LLDP は隣接エージェント間でパケットを交換し、それらの隣接情報を作成・維持します。図 5-1 はこれらの LLDP エージェントの隣接関係を示しています。LLDP にはカスタマブリッジ（CB）とサービスブリッジ（SB）の 2 つのブリッジモードがあります。

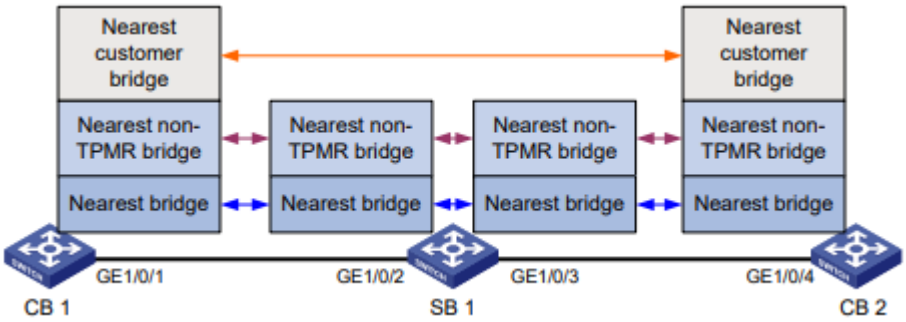

図 5-1 LLDP 隣接関係

II. LLDP フレームフォーマット

LLDP は LLDP フレームで装置情報を送信します。LLDP フレームは Ethernet II またはサブネットワークアクセスプロトコル（SNAP）フレームにカプセル化されます。

- Ethernet II でカプセル化された LLDP フレーム

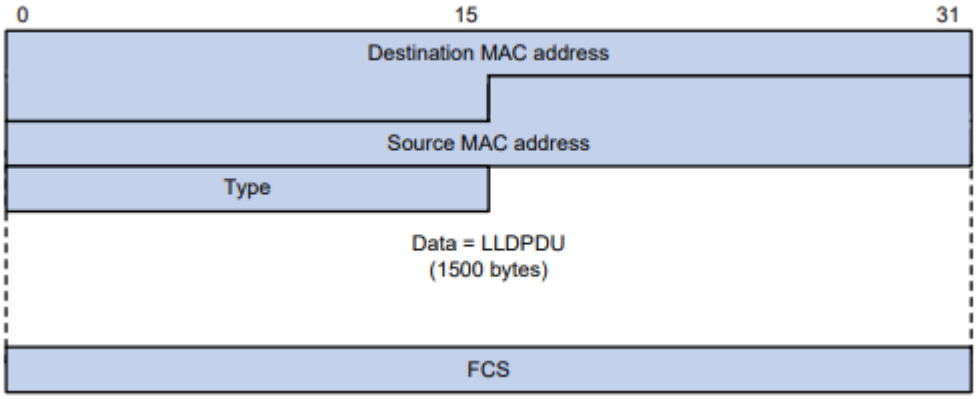

図 5-2 Ethernet II にカプセル化された LLDP フレーム

表 5-1 Ethernet II にカプセル化された LLDP フレームフィールド

フィールド	説明
Destination MAC address	LLDPフレームがアドバタイズされる宛先MACアドレス。LLDPは、異なるタイプのエージェント宛てのLLDPフレームに対して、異なるマルチキャストMACアドレスを宛先MACアドレスとして指定します。これにより、同一インタフェース上で異なるタイプのエージェントが送受信するLLDPフレームを区別できます。宛先MACアドレスは、以下のマルチキャストMACアドレスのいずれかに固定されます。 • nearest bridge エージェント宛ての LLDP フレームは 0x0180-c200-000E です。 • nearest customer bridge エージェント宛ての LLDP フレームは 0x0180-c200-0000 です。 • nearest non-TPMR bridg エージェント宛ての LLDP フレームは 0x0180-c200-0003 です。

フィールド	説明
Source MAC address	送信ポートのMACアドレスです。
Type	上位層プロトコルのEthernetタイプです。このフィールドはLLDPの場合0x88CCです。
Data	LLDPDUです。
FCS	フレームチェックシーケンスです。受信したEthernetフレームの有効性を判断するために使用される32ビットのCRC値です。

- SNAP でカプセル化された LLDP フレーム

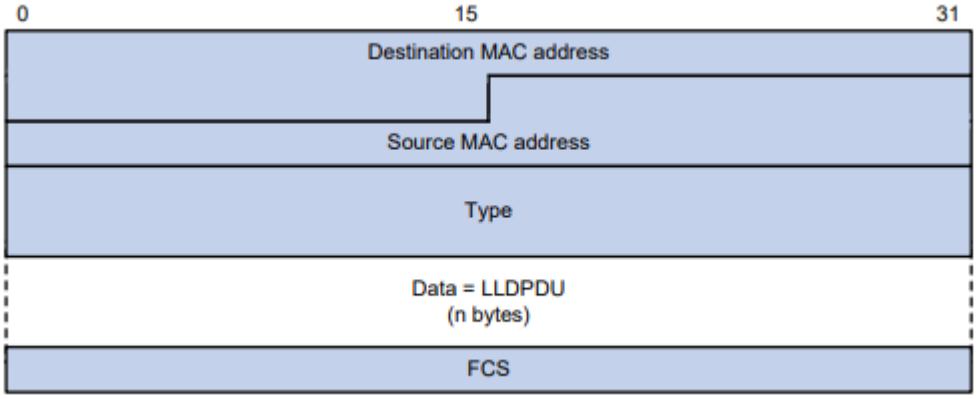

図 5-3 SNAP でカプセル化された LLDP フレーム

表 5-2 SNAP でカプセル化された LLDP フレームのフィールド

フィールド	説明
Destination MAC address	LLDPフレームがアドバタイズされるMACアドレスです。Ethernet IIカプセル化LLDPフレームの場合と同じです。
Source MAC address	送信ポートのMACアドレスです。
Type	上位層プロトコルのSNAPタイプです。このフィールドはLLDPの場合0xAAAA-0300-0000-88CCです。
Data	LLDPDUです。
FCS	フレームチェックシーケンスです。受信したEthernetフレームの有効性を判断するために使用される32ビットCRC値です。

III. LLDPDU

LLDP は、情報の交換に LLDPDU を使用します。LLDPDU は複数の TLV で構成されます。各 TLV は、図 5-4 に示すように、装置情報の種類を伝送します。

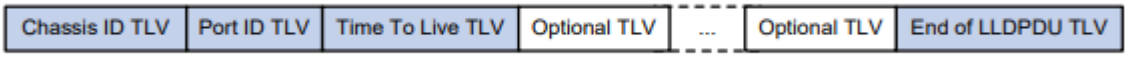

図 5-4 LLDPDU カプセル化フォーマット

LLDPDU は最大 32 種類の TLV を伝送可能です。必須 TLV には Chassis ID TLV、Port ID TLV、Time to Live TLV、End of LLDPDU TLV が含まれます。その他の TLV はオプションです。

IV. TLV

TLV は、タイプ、長さ、値のフィールドを含む情報要素です。

LLDPDU の TLV には以下のカテゴリがあります。

- 基本管理 TLV
- 組織固有（IEEE 802.1 および IEEE 802.3）の TLV
- LLDP-MED（media endpoint discovery）TLV

基本管理 TLV は装置管理に不可欠です。

組織固有の TLV および LLDP-MED TLV は、拡張された装置管理に使用されます。これらは標準化団体またはその他の組織によって定義され、LLDPDU に対してはオプションです。

- 基本管理 TLV

表 5-3 は基本管理 TLV のタイプを一覧表示します。その一部は LLDPDU に対して必須です。

表 5-3 基本管理 TLV

タイプ	説明	補足
Chassis ID	送信装置のBridge MACアドレスを指定します。	必須
Port ID	送信ポートのIDを指定します。 • LLDPDU が LLDP-MED TLV を保持する場合、Port ID TLV は送信ポートの MAC アドレスを保持します。 • それ以外の場合は、Port ID TLV はポート名を伝送します。	
Time to Live	受信装置における送信情報の有効期間を指定します。	
End of LLDPDU	LLDPDUのTLVシーケンスの終わりを示します。	オプション
Port Description	送信ポートの説明を指定します。	
System Name	送信装置の割り当て名を指定します。	
System Description	送信装置の説明を指定します。	
System Capabilities	送信装置の主な機能と有効化された主な機能を識別します。	
Management Address	以下の要素を指定します。 • ローカル装置の管理アドレス • アドレスに関連付けられたインタフェース番号およびオブジェクト識別子（OID）	

- IEEE 802.1 組織固有 TLV

表 5-4 IEEE 802.1 組織固有 TLV

タイプ	説明
Port VLAN ID (PVID)	ポートVLAN識別子(PVID)を指定します。
Port And Protocol VLAN ID (PPVID)	装置がプロトコルVLANをサポートするかどうかを示し、サポートする場合、これらのプロトコルが関連付けられるVLAN IDを示します。
VLAN Name	ポートが属するVLANのテキスト名を指定します。
Protocol Identity	ポートでサポートされるプロトコルを示します。
DCBX	Data center bridging exchangeプロトコルです。
EVB module	Edge Virtual Bridgingモジュールです。EVB TLVおよびCDCP TLVを含みます。
Link Aggregation	ポートがリンクアグリゲーションをサポートしているかどうか、サポートしている場合はリンクアグリゲーションが有効になっているかどうかを示します。
Management VID	Management VLAN IDです。
VID Usage Digest	VLAN ID usage digestです。
ETS Configuration	Enhanced Transmission Selection configurationです。
ETS Recommendation	ETS recommendationです。
PFC	Priority-based Flow Controlです。
APP	Application protocolです。
QCN	Quantized Congestion Notificationです。

メモ:

- NEC 装置は、protocol identity TLV と VID usage digest TLV の受信のみをサポートします。
- レイヤ 3Ethernet ポートは link aggregation TLV のみをサポートします。

- IEEE 802.3 組織固有 TLV

表 5-5 IEEE 802.3 組織固有 TLV

タイプ	説明
MAC/PHY Configuration/Status	ポートのビットレートおよびデュプレックス機能、オートネゴシエーションのサポート、オートネゴシエーションの有効化ステータス、現在のレートおよびデュプレックスモードを含みます。
Power Via MDI	ポートの電源供給機能を含みます。 • ポートクラス(PSE あるいは PD) • 電源供給モード • PSE 電源供給のサポート有無 • PSE 電源供給の有効/無効

タイプ	説明
	• ペア選択の制御可否 • 電源タイプ • 電源 • 電源優先度 • PD が要求した電力 • PSE が割り当てた電力
Maximum Frame Size	サポートされる最大フレームサイズを示します。このTLVはポートのMTUを表示します。
Power Stateful Control	送信ポートに設定された電源状態制御を示し、以下を含みます。 • PSE/PD の電源供給モード • PSE/PD の優先度 • PSE/PD の電源
Energy-Efficient Ethernet	省エネEthernet（EEE）を示します。

📖 メモ ：

Power Stateful Control TLV は IEEE P802.3at D1.0 で定義されており、それ以降のバージョンではサポートされていません。NEC 装置は、このタイプの TLV を受信した後にのみ送信します。

- LLDP-MED TLV

  LLDP-MED TLV は、基本設定、ネットワークポリシー設定、アドレスおよびディレクトリ管理など、VoIP（Voice over IP）向けの複数の高度なアプリケーションを提供します。LLDP-MED TLV は、Ethernet に音声装置を導入するための費用対効果が高く使いやすいソリューションを提供します。LLDP-MED TLV は表 5-6 に示されています。

表 5-6 LLDP-MED TLV

タイプ	説明
LLDP-MED Capabilities	ネットワーク装置がサポートするLLDP-MED TLVをアドバタイズすることを可能にします。
Network Policy	ネットワーク装置または端末装置が、ポートのVLAN ID、VLANタイプ、および特定のアプリケーション向けのレイヤ2およびレイヤ3の優先度をアドバタイズすることを可能にします。
Extended Power-via-MDI	ネットワーク装置または端末装置が電源供給能力をアドバタイズすることを可能にします。このTLVはPower Via MDI TLVの拡張です。
Hardware Revision	端末装置が自身のハードウェアバージョンをアドバタイズすることを可能にします。
Firmware Revision	端末装置が自身のファームウェアバージョンをアドバタイズすることを可能にします。
Firmware Revision	端末装置がソフトウェアバージョンをアドバタイズすることを可能にします。

タイプ	説明
Serial Number	端末装置が自身のシリアル番号をアドバタイズすることを可能にします。
Manufacturer Name	端末装置がベンダ名をアドバタイズすることを可能にします。
Model Name	端末装置がモデル名をアドバタイズすることを可能にします。
Asset ID	端末装置が自身のasset IDをアドバタイズすることを可能にします。典型的なケースは、ディレクトリ管理と資産追跡を容易にするために、ユーザがエンドポイントのasset IDを指定することです。
Location Identification	ネットワーク装置が、位置情報ベースのアプリケーションのコンテキストで端末装置が使用する適切な位置識別子情報をアドバタイズすることを可能にします。

メモ:

- MAC/PHY configuration/status TLV がアドバタイズ不可の場合、アドバタイズ可能な LLDP-MED TLV であっても一切アドバタイズされません。
- LLDP-MED capabilities TLV がアドバタイズ不可の場合、他の LLDP-MED TLV はアドバタイズ可能であってもアドバタイズされません。

V. 管理アドレス

ネットワーク管理システムは、トポロジ維持およびネットワーク管理のために、装置の管理アドレスを使用して装置を識別および管理します。管理アドレスは、management address TLV にカプセル化されます。

5.1.2. 動作メカニズム

I. LLDP 動作モード

LLDP エージェントは、以下のいずれかのモードで動作します。

- **TxRx モード** – このモードの LLDP エージェントは LLDP フレームの送受信が可能です。
- **Tx モード** – このモードの LLDP エージェントは LLDP フレームを送信することしかできません。
- **Rx モード** – このモードの LLDP エージェントは LLDP フレームを受信することしかできません。
- **Disable モード** – このモードの LLDP エージェントは、LLDP フレームの送信も受信もできません。

LLDP エージェントの LLDP 動作モードが変更されるたびに、その LLDP プロトコル状態マシンは再初期化されます。設定可能な再初期化遅延により、動作モードの頻繁な変更による初期化の頻発を防ぎます。再初期化遅延を設定した場合、LLDP エージェントは LLDP 動作モード変更後、指定された時間待機してから LLDP を初期化する必要があります。

II. LLDP フレームの送信

LLDP エージェントは、TxRx モードまたは Tx モードで動作する場合、直接接続された装置に対して LLDP フレームを定期的に送信するとともに、ローカル設定が変更された際にも送信します。ローカル装置情報の変更が頻繁に発生する時間帯に LLDP フレームがネットワークを圧迫するのを防ぐため、LLDP はトークンバケットメカニズムを用いて LLDP フレームのレート制限を行います。

LLDP は、以下のいずれかの場合に高速 LLDP フレーム伝送メカニズムを自動的に有効化します。

- 新しい LLDP フレームを受信し、ローカル装置にとって新規の装置情報を伝達します。
- LLDP エージェントの LLDP 動作モードが、Disable または Rx から TxRx または Tx に変更されます。

高速 LLDP フレーム送信メカニズムは、設定可能な高速 LLDP フレーム送信間隔で、指定された数の LLDP フレームを順次送信します。このメカニズムにより、LLDP 隣接機器はローカル装置を可能な限り早期に検出できます。その後、通常の LLDP フレーム送信間隔が再開されます。

III. LLDP フレームの受信

LLDP エージェントは、TxRx モードまたは Rx モードで動作する場合、受信したすべての LLDP フレームに含まれる TLV の有効性を確認します。TLV が有効な場合、LLDP エージェントは情報を保存し、エイジングタイマを開始します。エイジングタイマの初期値は、LLDP フレームに格納された Time To Live TLV の TTL 値と同じです。LLDP エージェントが新しい LLDP フレームを受信すると、エイジングタイマは再起動します。エイジングタイマがゼロになると、保存された情報はすべて期限切れになります。

5.1.3. プロトコルと規格

- IEEE 802.1AB-2005, *Station and Media Access Control Connectivity Discovery*
- IEEE 802.1AB-2009, *Station and Media Access Control Connectivity Discovery*
- ANSI/TIA-1057, *Link Layer Discovery Protocol for Media Endpoint Devices*
- *DCB Capability Exchange Protocol Specification Rev 1.00*
- *DCB Capability Exchange Protocol Base Specification Rev 1.01*
- IEEE Std 802.1Qaz-2011, *Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks-Amendment 18: Enhanced Transmission Selection for Bandwidth Sharing Between Traffic Classes*

5.2. LLDP設定作業リスト

作業リスト
基本LLDP設定の実行 • (必須設定項目) LLDP の有効化 • (オプション設定項目) LLDP 再初期化遅延の設定 • (オプション設定項目) アドバタイズ可能な TLV の設定 • (オプション設定項目) 管理アドレスとそのエンコード形式の設定 • (オプション設定項目) その他の LLDP パラメータの設定
(オプション設定項目) LLDPトラップおよびLLDP-MEDトラップの設定

5.3. 基本LLDP設定の実行

5.3.1. LLDP の有効化

特定のポートで LLDP を有効にするには、グローバルに LLDP を有効化するとともに、それらのポートでも有効化する必要があります。

LLDP を OpenFlow と併用するには、OpenFlow スイッチで LLDP をグローバルに有効にする必要があります。LLDP が OpenFlow コントローラのトポロジ検出に影響を与えないようにするには、OpenFlow インスタンスのポートで LLDP の受信と送信を無効にしてください。

LLDP を有効にするには:

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. LLDP をグローバルに有効化する	**lldp global enable**	デフォルト：無効
3. Ethernet interface view に移行する	**interface** *interface-id*	—
4. LLDP を有効にする	**lldp receive** **lldp transmit**	デフォルト : サポートされているすべてのポートでLLDP受信と送信が有効です。

5.3.2. LLDP 再初期化遅延の設定

ポートで LLDP 動作モードが変更されると、ポートは LLDP 再初期化遅延後にプロトコル状態マシンを初期化します。この遅延を調整することで、ポートの LLDP 動作モードが頻繁に変更されることによる頻繁な初期化を回避できます。

ポートの LLDP 再初期化遅延を設定するには：

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. LLDP 再初期化遅延を設定する	**lldp reinit** *seconds*	デフォルト：2秒

5.3.3. アドバタイズ可能な TLV の設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. Ethernet interface view に移行する	**interface** *interface-id*	—
3. 802.1AB 基本管理 TLV を設定する (Layer 2 Ethernet interface view)	**lldp tlv-select** [**port-description** | **system-capabilities** | **system-description** | **system-name**]	デフォルト：オプションの802.1AB基本管理TLVは選択されていません。

操作	コマンド	補足
4. IEEE 802.1 組織固有 TLV を設定する (Layer 2 Ethernet interface view)	**lldp dot1-tlv-select** { **port-vlan** | **vlan-name** [*vlan-id-list*] | **protocol-identity** [*protocol-name*] }	デフォルト：IEEE 802.1 組織固有TLVは選択されていません。
5. IEEE 802.3 組織固有 TLV を設定する (Layer 2 Ethernet interface view)	**lldp dot3-tlv-select** [**energy-efficient-eth** | **link-aggregation** | **mac-phy-cfg** | **max-frame-size** | **power-via-mdi** | **power-via-mdi-measurements**]	デフォルト：IEEE 802.3 組織固有TLVは選択されていません。
6. LLDP-MED TLV を設定する(Layer 2 Ethernet interface view)	**lldp med-tlv-select** [**capabilities** | **inventory-management** | **network-policy** | **power-management** | **location-id** [[**civic-address** *type country-code* [*sub-type country-code*]] | [**elin** *string*]]]	デフォルト：LLDP-MED TLVは選択されていません。

5.3.4. 管理アドレスとそのエンコード形式の設定

LLDP は、管理アドレス TLV において管理アドレスを数値形式または文字列形式でエンコードします。

隣接機器が管理アドレスを文字列形式でエンコードしている場合、接続ポートの管理アドレスのエンコード形式を **string** に設定してください。これにより、隣接機器との正常な通信が保証されます。

管理アドレス TLV のアドバタイズは、グローバルまたはインタフェース単位で設定できます。装置は、インタフェースに対する管理アドレス TLV アドバタイズ設定を以下の順序で選択します。

1. インタフェースベースの設定：**lldp management-address** [*ip-address* | *ipv6-address*]コマンドを使用して設定します。
2. インタフェースのデフォルト設定

   デフォルトでは：

   - LLDP 管理アドレスはアドバタイズされません。

管理アドレス TLV のアドバタイズを設定し、管理アドレスのエンコード形式を設定するには：

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. Ethernet interface view に移行する	**interface** *interface-id*	—
3. インタフェースで管理アドレス TLV のアドバタイズを有効にし、アドバタイズする管理アドレスを設定する	**lldp management-address** [*ip-address* | *ipv6-address*]	デフォルト：LLDP管理アドレスは設定されていません。

5.3.5. その他の LLDP パラメータの設定

LLDPDU に含まれる Time to Live TLV は、LLDPDU に含まれる装置情報を受信装置に保存できる期間を決定します。

TTL 乗数を設定することで、ローカルで送信される LLDPDU の TTL を設定できます。TTL は以下の式で表されます。

TTL = Min (65535, (TTL 乗数 × LLDP フレーム送信間隔 + 1))

この式が示す通り、TTL は最大 65535 秒まで設定可能です。65535 を超える TTL は 65535 秒に切り捨てられます。

LLDP パラメータの設定をするには：

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. TTL 乗数を設定する	**lldp hold-multiplier** *value*	デフォルト：4
3. LLDP フレーム送信間隔を設定する	**lldp tx-interval** *seconds*	デフォルト：30秒
4. 送信遅延タイマを設定する	**lldp tx-delay** *seconds*	デフォルト：2秒
5. 最小再初期化遅延間隔を設定する	**lldp reinit** *seconds*	デフォルト：2秒
6. LLDP-MED の高速開始リピート回数を設定する	**lldp fast-count** *value*	デフォルト：4

5.4. LLDPトラップおよびLLDP-MEDトラップの設定

LLDP トラップまたは LLDP-MED トラップは、新しく検出された隣接装置やリンク障害などのイベントをネットワーク管理システムに通知します。

トポロジが不安定な場合に過剰な LLDP トラップが送信されるのを防ぐため、LLDP のトラップ送信間隔を設定します。

LLDP トラップおよび LLDP-MED トラップを設定するには：

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. Ethernet interface view に移行する	**interface** *interface-id*	—
3. LLDP トラップを有効にする	**lldp notification enable**	デフォルト：無効
4. LLDP-MED トラップを有効にする	**lldp med notification enable**	デフォルト：無効
5. system view に戻る	**quit**	—
6. LLDP および LLDP-MED トラップ状態を有効にする	**snmp-agent trap enable lldp** [**med**]	デフォルト：LLDPおよびLLDP-MEDトラップは無効です。

5.5. LLDPの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
ローカルLLDP情報を表示する	**display lldp local interface** *interface-list* [**brief** | **detail**]
隣接装置から送信されたLLDP TLVに含まれる情報を表示する	**display lldp neighbors interface** *interface-list* [**brief** | **detail**]
LLDP統計情報を表示する	**display lldp traffic** [**interface** *interface-list*]
物理インタフェースのLLDP設定を表示する	**display lldp interface** *interface-list*
一般的なLLDP設定を表示する	**display lldp**

5.6. LLDP設定例

5.6.1. 基本的な LLDP の設定例

I. ネットワーク要件

図 5-5 に示すように、Switch A と Switch B で LLDP をグローバルに有効化し、以下の作業を実行します。

- NMS 上で Switch A と Switch B 間のリンクを監視します。
- NMS 上で Switch A と MED 装置間のリンクを監視します。

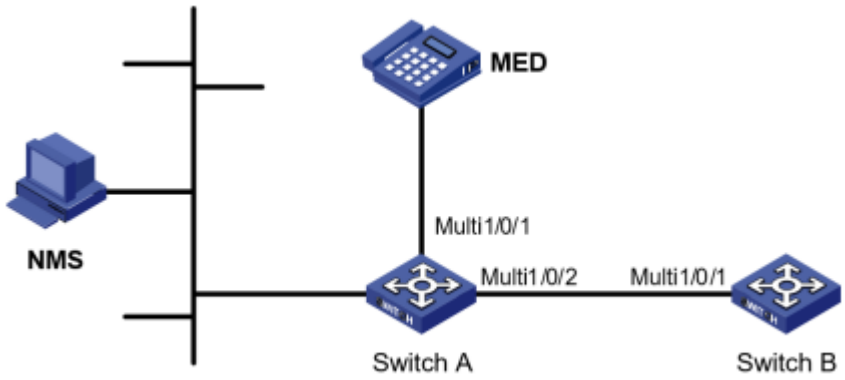

図 5-5 ネットワーク図

II. 設定手順

1. Switch A を設定します。

LLDP をグローバルに有効化します。

```
<SwitchA> system-view
[SwitchA] lldp global enable
```

Multi-GigabitEthernet 1/0/1 の LLDP 動作モードを Rx に設定します。

```
[SwitchA-Multi-GigabitEthernet1/0/1] lldp receive
[Switch-Multi-GigabitEthernet1/0/1] undo lldp transmit
[SwitchA-Multi-GigabitEthernet1/0/1] quit
```

Multi-GigabitEthernet 1/0/2 の LLDP 動作モードを Rx に設定します。

```
[SwitchA-Multi-GigabitEthernet1/0/2] lldp receive
[Switch-Multi-GigabitEthernet1/0/2] undo lldp transmit
[SwitchA-Multi-GigabitEthernet1/0/2] quit
```

2. Switch B を設定します。

LLDP をグローバルに有効化します。

```
<SwitchB> system-view
[SwitchB] lldp global enable
```

Multi-GigabitEthernet 1/0/1 の LLDP 動作モードを Tx に設定します。

```
[SwitchB-Multi-GigabitEthernet1/0/1] undo lldp receive
[SwitchB-Multi-GigabitEthernet1/0/1] lldp transmit
[SwitchB-Multi-GigabitEthernet1/0/1] quit
```

III. 設定の確認

以下の点を確認してください。

- Switch A の Multi-GigabitEthernet 1/0/1 は MED 装置に接続されています。
- Switch A の Multi-GigabitEthernet 1/0/2 は非 MED 装置に接続されています。
- 両ポートは Rx モードで動作し、LLDP フレームを受信できますが送信できません。

```
<SwitchA> display lldp

LLDP System Information
 Chassis ID Subtype : MAC Address
 Chassis ID : 00-11-78-90-CD-FF
System Name : SwitchA
 System Description : Software Version 1.0.14, QX-S924MT-4X-PW
 System Capabilities Supported : Bridge, Router
 System Capabilities Enabled : Bridge, Router

LLDP-MED System Information
 Device Class : Network Connectivity Device
 Hardware Revision : A1
 Software Revision : 1.0.14
 Serial Number :
 Manufacturer Name : NEC
 Model Name : QX-S924MT-4X-PW
 Asset ID :
 PoE Device Type : PSE Device
 PoE PSE Power Source : Primary
```

```
LLDP Configuration
 LLDP State : Enabled
 Message TX Interval : 30
 Message TX Hold Multiplier: 4
 ReInit Delay : 2
 TX Delay : 2
 Notification Interval : 5

LLDP-MED Configuration
 Fast Start Repeat Count : 4

<SwitchA> display lldp interface multi-GigabitEthernet 1/0/1

Port ID: multi1/0/1
------------------------------------------------------------------------------
Port ID :multi1/0/1
Admin Status :RX Only
Notification :Disabled
Basic Management TLVs:
 Port Description :Disabled
 System Name :Disabled
 System Description :Disabled
 System Capabilities :Disabled
 Enabled Management Address:
 (None)
IEEE 802.1 Organizationally Specific TLVs:
 Port VLAN ID :Disabled
 Enabled VLAN Name
 (None)
 Enabled Protocol_Identity
 (None)
IEEE 802.3 Organizationally Specific TLVs:
 MAC/PHY Configuration/Status :Disabled
 Power Via MDI :Disabled
 Link Aggregation :Disabled
 Maximum Frame Size :Disabled
 Energy Efficient Ethernet :Disabled
 Power via MDI Measurements :Disabled
LLDP-MED Organizationally Specific TLVs:
 LLDP-MED Capabilities TLV :Disabled
 LLDP-MED Network Policy TLV :Disabled
 LLDP-MED Location Identification TLV :Disabled
 LLDP-MED Extended Power Via MDI PSE TLV :Disabled
 LLDP-MED Inventory TLV :Disabled
```

```
<SwitchA> display lldp interface multi-GigabitEthernet 1/0/2

Port ID: multi1/0/2
------------------------------------------------------------------------------
Port ID :multi1/0/2
Admin Status :RX Only
Notification :Disabled
Basic Management TLVs:
 Port Description :Disabled
 System Name :Disabled
 System Description :Disabled
 System Capabilities :Disabled
 Enabled Management Address:
 (None)
IEEE 802.1 Organizationally Specific TLVs:
 Port VLAN ID :Disabled
 Enabled VLAN Name
 (None)
 Enabled Protocol_Identity
 (None)
IEEE 802.3 Organizationally Specific TLVs:
 MAC/PHY Configuration/Status :Disabled
 Power Via MDI :Disabled
 Link Aggregation :Disabled
 Maximum Frame Size :Disabled
 Energy Efficient Ethernet :Disabled
 Power via MDI Measurements :Disabled
LLDP-MED Organizationally Specific TLVs:
 LLDP-MED Capabilities TLV :Disabled
 LLDP-MED Network Policy TLV :Disabled
 LLDP-MED Location Identification TLV :Disabled
 LLDP-MED Extended Power Via MDI PSE TLV :Disabled
 LLDP-MED Inventory TLV :Disabled
<SwitchA>
```

Switch A と Switch B 間のリンクを削除します。

Switch A の Multi-GigabitEthernet 1/0/2 が隣接装置に接続されていないことを確認します。

```
<SwitchA> display lldp neighbors interface multi-GigabitEthernet 2

Remote Entities Count : 0
<SwitchA>
```

目次

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6章 ループ検出

6.1. 概要

不正なネットワークの接続あるいは設定は、レイヤ 2 のループを発生させます。そこでは、ブロードキャスト、マルチキャスト、不明なユニキャストパケットが繰り返し転送され、ネットワークリソースの枯渇が発生し、ネットワークが麻痺することがあります。ループ検出機能は、ループが発生したとき、ネットワークの接続と設定に対応するように通知させるため、すぐさまログを作成します。ループ検出はネットワークの接続と設定をシャットダウンすることができます。ログは Information center で維持されます。

6.1.1. ループ検出メカニズム

装置は検出フレームを送信し、装置のポートからフレームが戻るかどうかを確認することでループを検出します。検出した場合、装置はループされたリンクに接続されていると認識します。

ループ検出は通常 VLAN 内で動作します。検出フレームに送信されたフレームと異なる VLAN タグが付いている場合、内部 VLAN ループが発生しています。

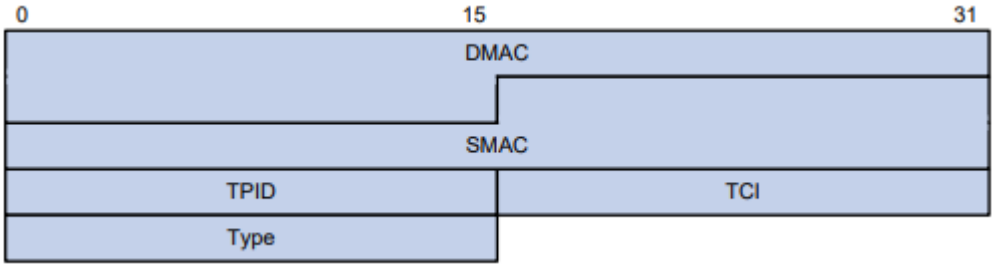

図 6-1 ループ検出のイーサネットフレームヘッダ

ループ検出のイーサネットフレームヘッダは以下のフィールドがあります。

- **DMAC** – フレームの宛先 MAC アドレスです。MAC アドレスは、マルチキャスト MAC アドレス 010F-E200-0007 です。ループ検出機能が有効で、この宛先 MAC アドレスのフレームを受信したとき、以下の処理を行います。
  - CPU にフレームを送信します。
  - フレームを最初に受信した VLAN にフラッドします。
- **SMAC** – フレームの送信元 MAC アドレスで、送信している装置の MAC アドレスです。
- **TPID** – VLAN タグのタイプで、0x8100 です。
- **TCI** – VLAN タグの情報で、優先度と VLAN ID が含まれます。
- **Type** – プロトコルタイプで、0x9000 です。

ループ検出のフレームは TLV（タイプ、長さ、値）としてカプセル化されます。

6.1.2. ループ検出間隔

ループ検出は、ネットワークの変化に対して連続して対応します。ループ検出フレームは、ループ検出間隔で、ポートにループが発生したかどうか、ループが取り除かれたかどうかを確認するために送信されます。

6.1.3. ループ保護アクション

装置がポートを検出したとき、ログを作成しますが、デフォルトでポートに何らかのアクションは実行しません。以下のアクションのうちの 1 つのアクションを行うように設定することができます。

- **Block** – ポートが MAC アドレスを学習する機能を無効にし、ポートをブロックします。
- **Shutdown** – フレームの送受信を無効にするため、ポートをシャットダウンします。

6.2. ループ検出設定作業リスト

作業リスト
(必須設定項目) ループ検出の有効化
(オプション設定項目) ループ検出間隔の設定

6.3. ループ検出の有効化

以下の要件が満たされている場合、ポートでループ検出が無効であったとしてもポートのループ保護アクションは開始することができます。

- 装置でループ検出がグローバルで有効、あるいはほかのすべてのポートで有効です。
- ポートは本装置からのループ検出フレームを受信します。

6.3.1. グローバルでのループ検出の有効化

操作	コマンド	補足
1. system view に移行する	**system-view**	–
2. グローバルでループ検出を有効にする	**loopback-detection global enable**	デフォルト：有効

6.3.2. ポートでのループ検出の有効化

操作	コマンド	補足
1. system view に移行する	**system-view**	–

操作	コマンド	補足
2. Layer 2 Ethernet interface view あるいは Layer 2 aggregate interface view に移行する	**interface** *interface-id*	—
3. ポートでループ検出を有効にする	**loopback-detection enable**	デフォルト： Multi-GigabitEthernetでは有効です。 Ten-GigabitEthernetでは無効です。

6.4. ループ検出間隔の設定

ループ検出が有効であるとき、装置は、指定された間隔でループ検出フレームを送信します。短い間隔では検出感度が上がりますが、より多くのリソースが消費されます。ループ検出間隔の設定を行うときには、システムのパフォーマンスとループ検出速度を考慮してください。

以下にループ検出間隔の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. ループ検出間隔を設定する	**loopback-detection interval-time** *seconds*	デフォルト：5秒

6.5. ループ検出の表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
ループ検出の設定と状態を表示する	**display loopback-detection** [**interface** *interface-list*]

6.6. ループ検出設定例

6.6.1. ループ検出設定例

I. ネットワーク要件

図 6-2 に示すように、以下の動作を行うようにループ検出の設定を行います。

- Device A がログを作成します。
- ループを検出したとき、自動的にポートのシャットダウンを行います。

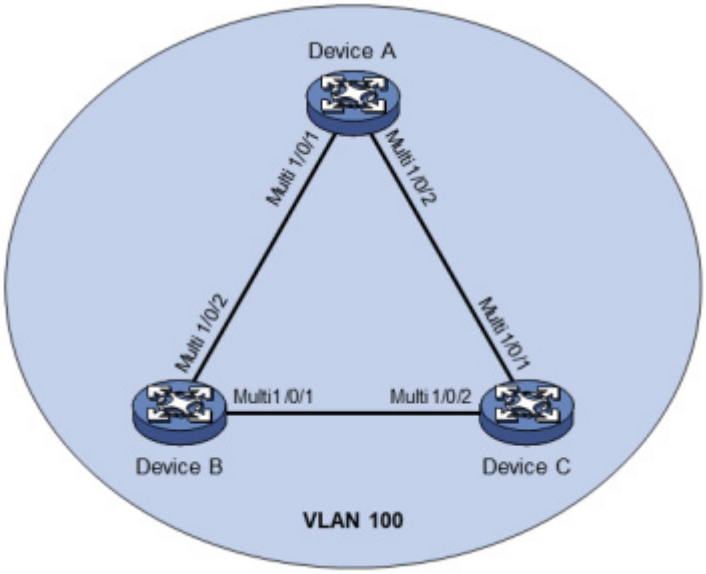

図 6-2 ネットワーク図

II. 設定手順

1. Device A を設定します。

VLAN100 を作成し、グローバルにループ検出を設定します。

```
<SwitchA> system-view
[SwitchA] vlan 100
[SwitchA-vlan100] quit
[SwitchA] loopback-detection global enable
```

Multi-GigabitEthernet 1/0/1 および Multi-GigabitEthernet 1/0/2 をトランクポートとして設定し、VLAN100 に割り当てます。

```
[SwitchA] interface Multi-GigabitEthernet 1/0/1
[SwitchA-Multi-GigabitEthernet1/0/1] port link-type trunk
[SwitchA-Multi-GigabitEthernet1/0/1] port trunk permit vlan 100
[SwitchA-Multi-GigabitEthernet1/0/1] port trunk pvid vlan 100
[SwitchA-Multi-GigabitEthernet1/0/1] quit
[SwitchA] interface Multi-GigabitEthernet 1/0/2
[SwitchA-Multi-GigabitEthernet1/0/2] port link-type trunk
[SwitchA-Multi-GigabitEthernet1/0/2] port trunk permit vlan 100
[SwitchA-Multi-GigabitEthernet1/0/2] port trunk pvid vlan 100
[SwitchA-Multi-GigabitEthernet1/0/2] quit
```

Multi-GigabitEthernet 1/0/1 および Multi-GigabitEthernet 1/0/2 のループ保護アクションをシャットダウンに設定します。

```
[SwitchA] interface range multi-GigabitEthernet 1/0/1 multi-GigabitEthernet 1/0/2
[SwitchA-if-range] loopback-detection action shutdown
[SwitchA-if-range] loopback-detection enable
[SwitchA-if-range] quit
```

ループ検出間隔を 35 秒に設定します。

```
[SwitchA] loopback-detection interval-time 35
```

2. Device B を設定します。

VLAN100 を作成します。

```
<SwitchB> system-view
[SwitchB] vlan 100
[SwitchB-vlan100] quit
```

Multi-GigabitEthernet 1/0/1 および Multi-GigabitEthernet 1/0/2 をトランクポートとして設定し、VLAN100 に割り当てます。

```
[SwitchB] interface Multi-GigabitEthernet 1/0/1
[SwitchB-Multi-GigabitEthernet1/0/1] port link-type trunk
[SwitchB-Multi-GigabitEthernet1/0/1] port trunk permit vlan 100
[SwitchB-Multi-GigabitEthernet1/0/1] port trunk pvid vlan 100
[SwitchB-Multi-GigabitEthernet1/0/1] quit
[SwitchB] interface Multi-GigabitEthernet 1/0/2
[SwitchB-Multi-GigabitEthernet1/0/2] port link-type trunk
[SwitchB-Multi-GigabitEthernet1/0/2] port trunk permit vlan 100
[SwitchB-Multi-GigabitEthernet1/0/2] port trunk pvid vlan 100
[SwitchB-Multi-GigabitEthernet1/0/2] quit
```

3. Device C を設定します。

VLAN100 を作成します。

```
<SwitchC> system-view
[SwitchC] vlan 100
[SwitchC-vlan100] quit
```

Multi-GigabitEthernet 1/0/1 および Multi-GigabitEthernet 1/0/2 をトランクポートとして設定し、VLAN100 に割り当てます。

```
[SwitchC] interface Multi-GigabitEthernet 1/0/1
[SwitchC-Multi-GigabitEthernet1/0/1] port link-type trunk
[SwitchC-Multi-GigabitEthernet1/0/1] port trunk permit vlan 100
[SwitchC-Multi-GigabitEthernet1/0/1] port trunk pvid vlan 100
[SwitchC-Multi-GigabitEthernet1/0/1] quit
[SwitchC] interface Multi-GigabitEthernet 1/0/2
[SwitchC-Multi-GigabitEthernet1/0/2] port link-type trunk
[SwitchC-Multi-GigabitEthernet1/0/2] port trunk permit vlan 100
[SwitchC-Multi-GigabitEthernet1/0/2] port trunk pvid vlan 100
[SwitchC-Multi-GigabitEthernet1/0/2] quit
```

III. 設定の確認

装置（Device A など）のシステムログを表示します。

```
[SwitchA]<186>1 2025-09-22T16:38:26.391328+09:00 QX-S916MT-4X-PW LBD 584 - -
MultiGigabitEthernet1/0/1 loop occurred.
<186>1 2025-09-22T16:38:26.393658+09:00 QX-S916MT-4X-PW LBD 584 - -
Multi-GigabitEthernet1/0/2 loop
occurred.
```

出力内容は、以下のことを示します。

- Device A は、ループ検出間隔内に Multi-GigabitEthernet 1/0/1 および Multi-GigabitEthernet 1/0/2 でループを検出しました。

display loopback-detection コマンドを使用して、装置（Device A など）のループ検出の設定と情報を表示します。

```
[SwitchA] display loopback-detection
Loopback Detection : Enabled
Interval : 35 seconds
Function Version : v4.05
Interface State Action Result Time Left (sec)
-------------------- -------- -------- ----------------- ---------------
multi1/0/1 Enabled Shutdown Normal -
multi1/0/2 Enabled Shutdown Normal -
...
```

出力はシャットダウンアクションに従って、Multi-GigabitEthernet 1/0/1、Multi-GigabitEthernet 1/0/2 ポートがループから開放されたことを示しています。

装置（Device A など）上の Multi-GigabitEthernet 1/0/1 の状態を表示します。

```
[SwitchA] display interfaces multi-GigabitEthernet 1/0/1
multi1/0/1 is enabled link status is down (error disabled: CTP LBD)
...
```

出力は、Multi-GigabitEthernet 1/0/1 がループ検出アクションによってシャットダウンしていることを示しています。

装置（Device A など）上の Multi-GigabitEthernet 1/0/2 の状態を表示します。

```
[SwitchA] display interfaces multi-GigabitEthernet 1/0/2
multi1/0/2 is enabled link status is down (error disabled: CTP LBD)
...
```

出力は、Multi-GigabitEthernet 1/0/2 がループ検出アクションによってシャットダウンしていることを示しています。

メモ:

ループ検出を解除するためには、ループしていない構成に変更し、対象インタフェースに shutdown を実行後、undo shutdown を実行することで、解除されます。

errdisable recovery cause loop-detection を設定している場合は、ループしていない構成に変更してから、指定したインターバル経過後に解除されます。

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7章 VLAN

7.1. 概要

イーサネットは、CSMA/CD 方式に基づく共有通信型 LAN 技術の一種です。イーサネット LAN は衝突ドメインでとブロードキャストドメインの両方の性質を持ちます。通信媒体を複数の端末で共有しているため、衝突（コリジョン）やブロードキャストが頻繁に発生します。通常、ブリッジやレイヤ 2 スイッチによって、イーサネット LAN 内の衝突を減らすことができます。また、ブロードキャストを制限するためには、レイヤ 2 スイッチで VLAN（仮想 LAN）技術を使用する必要があります。

図 7-1 のように VLAN を使用して、LAN を小さく分割することで、ブロードキャストドメインの影響を少なくすることができます。

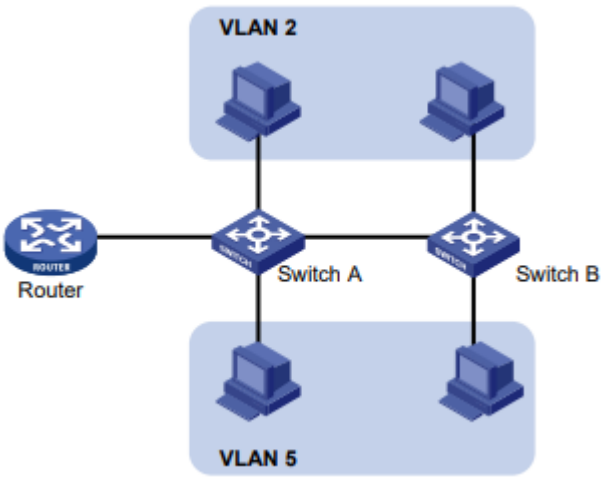

図 7-1 VLAN ネットワーク図

VLAN は物理的な要素からは制限を受けません。たとえば、特定のワークグループによって使用されるすべてのワークステーションとサーバは物理的な位置に関係なく、同じ LAN に接続することができます。異なる VLAN 間と通信するためにはルータやレイヤ 3 スイッチが必要となります。

これらすべての VLAN 機能は、帯域幅の無駄を減らし、LAN のセキュリティを向上させ、柔軟な仮想グループの作成を可能にします。

7.1.1. VLAN フレームのカプセル化

異なる VLAN からのイーサネットフレームを識別するために、IEEE 802.1Q は宛先/送信元 MAC アドレス (DA&SA)フィールドとタイプフィールドの間に 4 byte の VLAN タグを追加します。

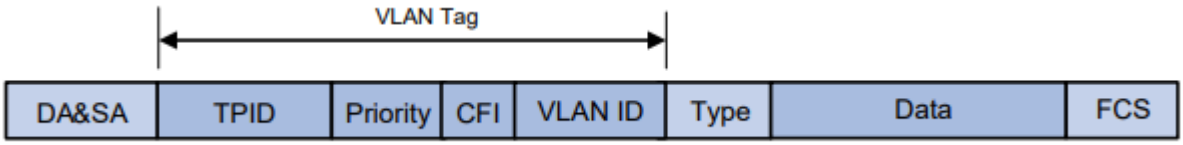

図 7-2 VLAN タグの位置とフォーマット

VLAN タグには以下のフィールドが含まれます。

- **TPID** – フレームに VLAN タグが付いているかどうかを識別するためのプロトコル識別子です。このフィールドは 16 ビット長です。デフォルトで TPID は 0x8100 で VLAN タグが付いています。装置ベンダは TPID を別の値に設定できます。隣接する装置との互換性を確保するためには、TPID の値を隣接装置と同じ値に設定してください。
- **Priority** – フレームの 802.1p 優先度を示します。このフィールドは 3 ビット長です。
- **CFI** – 標準フォーマットを示すフィールドです。このフィールドは 1 ビット長です。パケットが異なるメディアを跨いで転送されるとき、MAC アドレスは標準フォーマットでカプセル化されます。以下の値が設定できます。
  - **0（デフォルト）** – MAC アドレスは標準フォーマットでカプセル化されます。
  - **1** — MAC アドレスが非標準フォーマットでカプセル化されます。

    Ethernet のフィールドは常に 0 です。
- **VLAN ID** – フレームが所属する VLAN を示します。このフィールドは 12 ビット長です。VLAN-ID の範囲は 0～4095 です。0 と 4095 はプロトコルによって予約されているので、実際に使える値は 1～4094 となります。

フレームを受信したとき、ネットワーク装置はフレームに VLAN タグが付いているか、そして VLAN タグの値を確認して処理を決定します。

イーサネットは、Ethernet II、802.3/802.2 LLC、802.3/802.2 SNAP、802.3 raw などのカプセル化フォーマットをサポートしています。ここでは Ethernet II カプセル化フォーマットを使用しています。VLAN タグフィールドは VLAN を識別するために、これらのカプセル化フォーマットにも付与されます。詳細は関連するプロトコルと標準を参照してください。

複数のタグ付きフレームのために、装置はもっとも外側の VLAN タグに従って処理し、ペイロードとしてその内部の VLAN タグを送信します。

7.1.2. プロトコルと標準

IEEE 802.1Q, IEEE Standard for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks

7.2. VLANの設定

VLAN を設定する場合、以下の制限事項とガイドラインに従ってください。

- デフォルト VLAN である VLAN1 は作成または削除できません。
- アプリケーションによってロックされているダイナミック VLAN または VLAN を削除する前に、VLAN から設定を削除する必要があります。

以下に VLAN の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. （オプション設定項目）VLAN を作成し、view に移行あるいは VLAN リストを作成する	**vlan** *vlan-id-list*	デフォルト： デフォルトVLAN(VLAN1)のみ
3. VLAN view 移行する	**vlan** *vlan-id*	VLANリストを作成した後、VLANを設定するには、この操作を実行してください。
4. VLAN の名前を設定する	**name** *text*	デフォルト：**VLAN** *vlan-id* 4桁の形式でVLAN IDを指定します。VLAN IDが4桁未満の場合、先頭に0が追加されます。たとえばVLAN 100のVLAN名はVLAN 0100です。
5. VLAN の説明を設定する	**description** *text*	デフォルト：設定なし

7.3. VLANインタフェースの設定

異なる VLAN のホストは、レイヤ 3 で通信するために VLAN インタフェースを使用します。VLAN インタフェースは仮想インタフェースであり、装置上の VLAN インタフェースは物理的には存在しません。各 VLAN は、1 つの VLAN インタフェースを作成することができます。VLAN インタフェースには IP アドレスを割り当てることができ、そしてそれをゲートウェイとすることで、異なる IP ネットワークセグメントへのトラフィックを転送することが可能となります。

VLAN インタフェースを設定する場合、以下の制限事項とガイドラインに従ってください。

- VLAN の VLAN インタフェースを作成する前に、最初に VLAN を作成してください。

以下に VLAN インタフェースの設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. VLAN インタフェースを作成し、その view に移行する	**interface vlan-interface** *interface-number*	VLANが存在する場合、直接そのviewに移行します。 デフォルト：インタフェース VLAN 1 が存在します。
3. VLAN インタフェースに IP アドレスを割り当てる	**ip address** { *ip-address* { *mask-length* | *subnet-mask* } | **dhcp** }	デフォルト：設定なし
4. VLAN インタフェースの説明を設定する	**description** *string*	デフォルト：設定なし
5. （オプション設定項目）VLAN インタフェースをアップ状態にする	**undo shutdown**	—

7.4. ポートベースVLAN の設定

7.4.1. はじめに

ポートベース VLAN はポートに VLAN を割り当てます。VLAN を割り当てられたポートはその VLAN のトラフィックだけを転送します。

I. ポートリンクタイプ

ポートリンクタイプはアクセス、トランク、ハイブリッドに設定することができます。ポートのリンクタイプによって、そのポートが複数の VLAN に所属できるかどうかが決まります。リンクタイプは、異なる VLAN タグの処理方法を使用します。

- **アクセス** – アクセスーアクセスポートは 1 つの VLAN にのみ所属することができます。タグが付与されずにパケットを送信します。アクセスポートは通常、以下の場合で使用されます。
  - VLAN パケットをサポートしない端末に接続します
  - VLAN を区別できない装置に接続します
- **トランク** – トランクポートは複数の VLAN に所属することができ、複数の VLAN のトラフィックを送受信可能です。デフォルト VLAN（PVID）以外のトラフィックがトランクポートを通過するとき、そのトラフィックには VLAN タグが付与されます。通常、同じ VLAN を持つネットワーク装置と接続するのに使用されます。
- **ハイブリッド** – ハイブリッドポートは複数の VLAN からパケットを転送することができます。ハイブリッドポートに転送されたパケットのタグの状態はポートの設定に依存します。

II. PVID

PVID は、ポートのデフォルト VLAN です。ポートで受信されたタグなしパケットは PVID のポートから受信されたパケットとして認識されます。

ポートに PVID を設定する際は、以下の制限とガイドラインに従ってください。

- アクセスポートは 1 つの VLAN だけに接続できます。 アクセスポートが属する VLAN は、ポートの PVID です。
- トランクポートまたはハイブリッドポートは複数の VLAN をサポートし、設定できる PVID は 1 つだけです。
- **undo vlan** コマンドで PVID を削除すると、ポートのタイプによって以下のいずれかの動作をします。
  - アクセスポートでは、PVID は VLAN1 になります。
  - トランクまたはハイブリッドポートでは、PVID の設定に影響はありません。

  ハイブリッドポート、トランクポート、アクセスポートのいずれに対しても、存在しない VLAN を PVID として割り当てることができます。アクセスポートの場合、その存在しない VLAN は自動的に作成されます。
- ローカルとリモートで同じ PVID を設定することを推奨します。
- ポートで PVID からのパケットとタグなしパケットを廃棄しないように、ポートを PVID に割り当ててください。

7.4.2. アクセスポート VLAN の設定

VLAN view または interface view で、アクセスポートを VLAN に割り当てることができます。割り当てる前に、VLAN が作成されていることを確認してください。

I. interface view でのアクセス VLAN の設定方法

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. interface view に移行する	• Layer 2 Ethernet interface view に移行する: **interface** *iinterface-id* • Layer 2 aggregate interface view に移行する: **interface bridge-aggregation** *interface-number*	—
3. リンクタイプをアクセスに設定する	**port link-type access**	デフォルト：アクセス
4. （オプション設定項目）アクセスポートを VLAN に割り当てる	**port access vlan** *vlan-id*	デフォルト： VLAN 1 に属します。

7.4.3. トランクポート VLAN の設定

トランクポートは複数の VLAN に所属することができます。トランクポート VLAN の設定は、interface view で VLAN に割り当てることができます。

VLAN にトランクポートを割り当てるとき、以下の制限とガイドラインに従ってください。

- ポートのリンクタイプをトランクモードに変更します。
- トランクポートが PVID からパケットを送信できるようにするには、**port trunk permit vlan** コマンドを使用してトランクポートを PVID に割り当てる必要があります。

以下にトランクポートを 1 つまたは複数の VLAN に割り当てる設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. interface view に移行する	• Layer 2 Ethernet interface view に移行する: **interface** *interface-id* • Layer 2 aggregate interface view に移行する: **interface bridge-aggregation** *interface-number*	—
3. リンクタイプをトランクに設定する	**port link-type trunk**	デフォルト：アクセス

操作	コマンド	補足
4. トランクポートを指定された VLAN に割り当てる	**port trunk permit vlan** { *vlan-id-list* | **all** }	デフォルト：すべてのVLANが許可されています。
5. (オプション設定項目) トランクポートの PVID を設定する	**port trunk pvid vlan** { *vlan-id* | **tag** }	デフォルト： VLAN 1

7.4.4. ハイブリッドポート VLAN の設定

ハイブリッドポートは複数の VLAN に所属することができます。ハイブリッドポート VLAN の設定は、interface view で VLAN に割り当てることができます。ハイブリッドポートを VLAN に割り当てる前に、対応する VLAN が作成されている必要があります。

VLAN にハイブリッドポートを割り当てるとき、以下のガイドラインに従ってください。

- ポートのリンクタイプをハイブリッドに変更するには、まずハイブリッドモードに設定する必要があります。
- ハイブリッドポートが自身の PVID からパケットを送信できるようにするには、**switchport hybrid allowed vlan** コマンドを使用してハイブリッドポートを PVID に割り当てる必要があります。

以下にハイブリッドポートを 1 つまたは複数の VLAN に割り当てる設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. interface view に移行する	• Layer 2 interface view に移行する: **interface** *interface-id* • Layer 2 aggregate interface view に移行する: **interface bridge-aggregation** *interface-number*	—
3. リンクタイプをハイブリッドに設定する	**port link-type hybrid**	デフォルト：アクセス
4. 指定した VLAN にハイブリッドポートを割り当てる	**switchport hybrid allowed vlan** { [**add**] { **tagged** | **untagged** } | **remove** } *vlan-id-list*	デフォルト：VLAN 1のみ許可
5. (オプション設定項目) ハイブリッドポートの PVID を設定する	**port hybrid pvid vlan** *vlan-id*	デフォルト：VLAN 1

7.5. VLANの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
VLANインタフェース情報を表示する	**display vlan interface** [*interface-list*]
VLAN情報を表示する	**display vlan** [*vlan-id-list*]

7.6. VLAN設定例

7.6.1. ポートベース VLAN の設定例

I. ネットワーク要件

図 7-3 に示すように設定します。

- Host A と Host C は部署 A に属しています。VLAN100 は部署 A に割り当てられています。
- Host B と Host D は部署 B に属しています。VLAN200 は部署 B に割り当てられています。

ポートベース VLAN を設定し、同一部門内のホスト間のみが相互通信できるようにします。

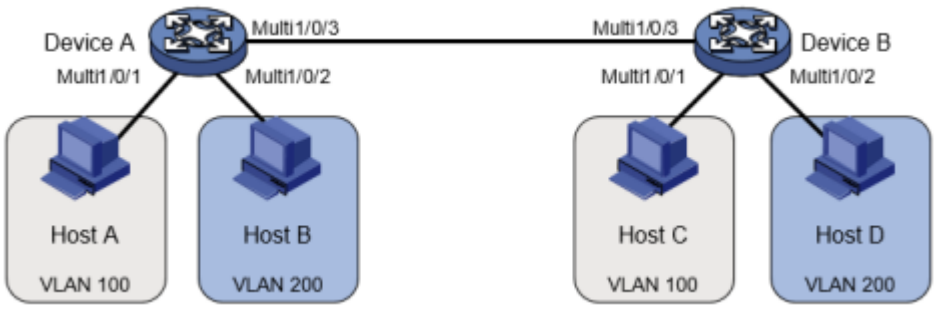

図 7-3 ネットワーク図

II. 設定手順

1. Device A を設定します。

VLAN100 を作成し、Multi-GigabitEthernet 1/0/1 に割り当てます。

```
<SwitchA> system-view
[SwitchA] vlan 100
[SwitchA-vlan100] quit
[SwitchA] interface multi-GigabitEthernet 1/0/1
[SwitchA-Multi-GigabitEthernet1/0/1] port link-type access
[SwitchA-Multi-GigabitEthernet1/0/1] port access vlan 100
[SwitchA-Multi-GigabitEthernet1/0/1] quit
```

VLAN200 を作成し、Multi-GigabitEthernet 1/0/2 に割り当てます。

```
[SwitchA] vlan 200
[SwitchA-vlan200] quit
[SwitchA] interface multi-GigabitEthernet 1/0/2
[SwitchA-Multi-GigabitEthernet1/0/2] port link-type access
```

```
[SwitchA-Multi-GigabitEthernet1/0/2] port access vlan 200
[SwitchA-Multi-GigabitEthernet1/0/2] quit
```

Multi-GigabitEthernet 1/0/3 をトランクポートとして設定し、VLAN100、200 に割り当てます。

```
[SwitchA] interface multi-GigabitEthernet 1/0/3
[SwitchA-Multi-GigabitEthernet1/0/3] port link-type trunk
[SwitchA-Multi-GigabitEthernet1/0/3] port trunk permit vlan 100 200
```

2. Device A と同様に Device B の設定を行います。（詳細は省略します）
3. host を設定します。
   a. Host A と Host C を同じ IP サブネット上に設定します。例：192.168.100.0/24
   b. Host B と Host D を同じ IP サブネット上に設定します。例：192.168.200.0/24

III. 設定の確認

Host A と Host C が相互に ping でき、Host B と Host D への ping は失敗することを確認します。（詳細はします）

Host B と Host D が相互に ping でき、Host A と Host C への ping は失敗することを確認します。（詳細はします）

Device A で VLAN100 および 200 が正しく設定されていることを確認します。

```
<SwitchA> display vlan 100
VLAN 100
 Name : VLAN0100
 Description :
 Tagged Member Ports : multi1/0/3
 Untagged Member Ports : multi1/0/1
Total Entries : 1
<SwitchA> display vlan 200
VLAN 200
 Name : VLAN0200
 Description :
 Tagged Member Ports : multi1/0/3
 Untagged Member Ports : multi1/0/2
Total Entries : 1
```

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

3. IP サービス

本マニュアルは以下に示す章で構成されています。

01-ARP

02-Gratuitous ARP

03-IP アドレス

04-DHCP クライアント

05-DNS

目次

このセクションのページは **3-x-x** です。

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1.1.3. ARP テーブル 1-3
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1章 ARP

1.1. 概要

ARP（Address Resolution Protocol）は、IP アドレスをもとに MAC アドレス(物理アドレス)情報を得ることができます。

1.1.1. ARP メッセージフォーマット

ARP は ARP 要求/応答メッセージの 2 つのメッセージタイプがあります。図 1-1 は RP 要求/応答メッセージのフォーマットを示します。図の数字はフィールド長を示します。

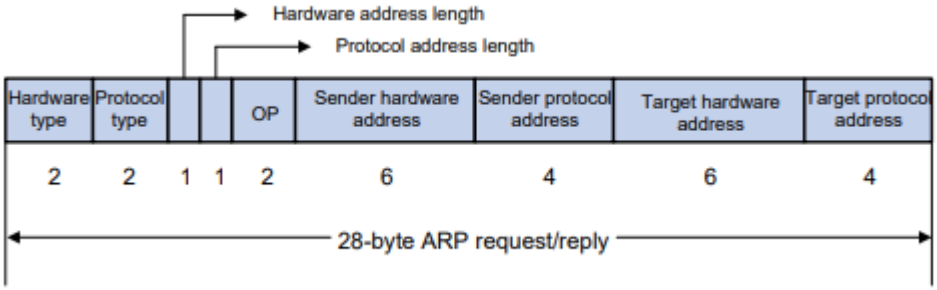

図 1-1 ARP メッセージ形式

- **Hardware type** – ハードウェアアドレスタイプを指定します。1 は Ethernet を表します。
- **Protocol type** – マッピングされるプロトコルアドレスのタイプを指定します。16 進数で 0x0800 は IP を表します。
- **Hardware address length and protocol address length** – ハードウェアアドレスの長さと、プロトコルアドレスの長さをバイト単位で指定します。イーサネットアドレスに関して、Hardware address length の値は 6 です。IPv4 アドレスに関しては、protocol address length の値は 4 です。
- **OP** – Operation code は ARP メッセージのタイプを指定します。1 は ARP 要求、2 は ARP 応答を表します。
- **Sender hardware address** – メッセージを送信する装置のハードウェアアドレスを指定します。
- **Sender protocol address** – メッセージを送信する装置のプロトコルアドレスを指定します。
- **Target hardware address** – メッセージが送信られる装置のハードウェアアドレスを指定します。
- **Target protocol address** – メッセージが送信られる装置のプロトコルアドレスを指定します。

1.1.2. ARP 動作メカニズム

図 1-2 に示すように、Host A と Host B は同一サブネットにあります。Host A は Host B に以下のようにパケットを送信します。

1. Host A は Host B の ARP エントリが ARP テーブルにあるか検索します。もし ARP エントリがある場合、Host A は、ARP エントリの MAC アドレスを使用します。そしてデータリンクレイヤのフレームに IP パケットをカプセル化し、Host B にフレームを送信します。
2. もし Host B の ARP エントリがない場合、Host A はパケットをバッファし、ARP 要求をブロードキャストします。ARP リクエストのデータの内容は以下の情報が含まれます。
   - **送信元 IP アドレスと送信元 MAC アドレス** – Host A の IP アドレスと MAC アドレス
   - **宛先 IP アドレス** – Host B の IP アドレス
   - **宛先 MAC アドレス** – 値がすべて 0 の MAC アドレス

   サブネットのすべてのホストはブロードキャストリクエストを受信することができますが、パケットを処理するホスト（Host B）のみが ARP 要求を処理します。
3. Host B は自身の IP アドレスと ARP リクエストの宛先 IP アドレスを比較し、同一の場合、以下の処理を行います。
   a. 送信元 IP アドレスと送信元 MAC アドレスを自身の ARP テーブルに追加します。
   b. ARP 応答に自身の MAC アドレスを挿入します。
   c. Host A に ARP 応答をユニキャストで送信します。
4. ARP 応答を受信した後、Host A は以下の処理を行います。
   a. Host B の MAC アドレスを自身の ARP テーブルに追加します。
   b. MAC アドレスをパケットに追加し、Host B にそのパケットを送信します。

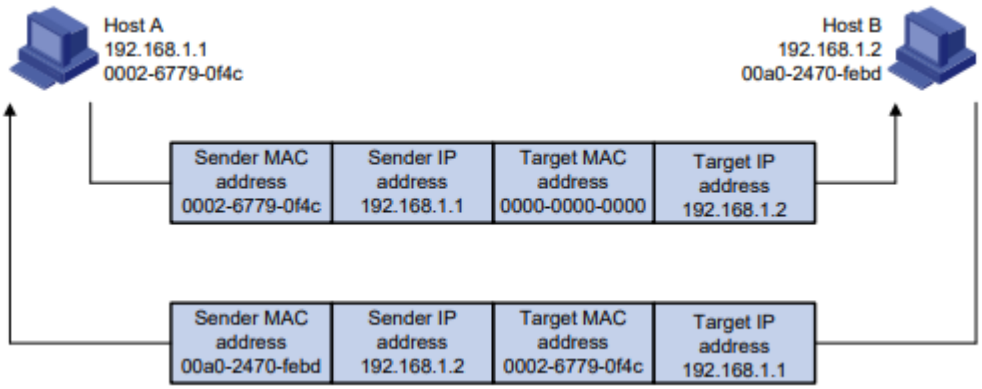

図 1-2 ARP アドレス解決プロセス

Host A と Host B が異なるサブネットにある場合、Host A は Host B に以下のようにパケットを送信します。

5. Host A は、宛先 IP アドレスをゲートウェイの IP アドレスにした ARP 要求をブロードキャストします。。
6. ゲートウェイは、ARP 応答を行い、自身の MAC アドレスを Host A に送信します。
7. Host A はゲートウェイの MAC アドレスをパケットに挿入し、ゲートウェイにパケットを送信します。 。

8. ゲートウェイが Host B の ARP エントリがある場合、Host B にパケットを直接転送します。もし Host B の ARP エントリがない場合、宛先 IP アドレスを Host B の IP アドレスとして ARP 要求をブロードキャストします。
9. ゲートウェイが Host B の MAC アドレスを取得した後、Host B にパケットを送信します。

1.1.3. ARP テーブル

ARP テーブルはダイナミック、スタティックの ARP エントリがあります。

I. ダイナミック ARP エントリ

ダイナミックエントリは ARP によって自動的に作成、アップデートされます。エージングタイマが終了したとき、あるいは出力インタフェースがダウンしたとき、ダイナミックエントリは削除されます。ダイナミック ARP エントリはスタティック ARP エントリによって上書きされます。

II. スタティック ARP エントリ

スタティック ARP エントリは手動で設定され、維持します。スタティック ARP エントリはエージングせず、ダイナミック ARP エントリによって上書きされることもありません。

スタティック ARP エントリは、攻撃パケットによってスタティック ARP エントリ内の IP-MAC マッピングを変更できないため、装置間の通信を保護します。

1.2. スタティックARPエントリの設定

スタティック ARP エントリは、装置が正常に動作するときに、適用されます。

解決済みのスタティック ARP エントリは、未解決となります。たとえば、解決した出力インタフェースがダウンあるいは対応する VLAN、VLAN インタフェースが削除したとき、解決済みのスタティック ARP エントリは、未解決となります。

以下にスタティック ARP エントリの設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. スタティック ARP エントリを設定する	• スタティック ARP エントリを設定する **arp** *ip-address hardware-address*	デフォルト：設定なし

1.3. ダイナミックARPエントリのエージングタイマの設定

ARP テーブル内の各ダイナミック ARP エントリには、エージングタイマと呼ばれる有効期限があります。ダイナミック ARP エントリのエージングタイマは、そのエントリが更新されるたびにリセットされます。有効期限切れになる前に更新されなかったダイナミック ARP エントリは、ARP テーブルから削除されます。

以下にダイナミック ARP エントリのエージングタイマの設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. VLAN インタフェースを作成し、その view に移行する	**interface vlan-interface** *interface-number*	VLANインタフェースが既に存在する場合、そのviewを直接入力します。 デフォルトでは、インタフェース VLAN 1 が存在します。
3. ダイナミック ARP エントリのエージングタイマを設定する	**arp timeout** *minutes*	デフォルト：20分

1.4. ARPの表示と維持

⚠ 重要:

ARP テーブルからエントリを削除すると通信障害が発生する可能性があります。ARP エントリを削除した場合は、その後の通信に影響がないことを確認してください。

すべての view で **display** コマンドを実行でき、user view で **reset** コマンドが実行できます。

操作	コマンド
ARPエントリを表示する	**display arp** [*arp-type*] [*ip-address* [*mask*]] [*interface-id*] [*hardware-address*]
ダイナミックARPエントリのエージングタイマを表示する	**display arp timeout** [**interface** *interface-id*]
ARPテーブルからARPエントリを削除する	**reset arp-cache** { **all** | **interface** *interface-id* | *ip-address* }

1.5. ARP設定例

1.5.1. スタティック ARP エントリ設定例

I. ネットワーク要件

図 1-3 に示すように、ホストは Device B に接続されています。Device B は、VLAN 10 の Multi-GigabitEthernet 1/0/1 によって Device A に接続されています。

Device A と Device B 間の安全な通信を確保するため、Device B で Device A のスタティック ARP エントリを設定します。

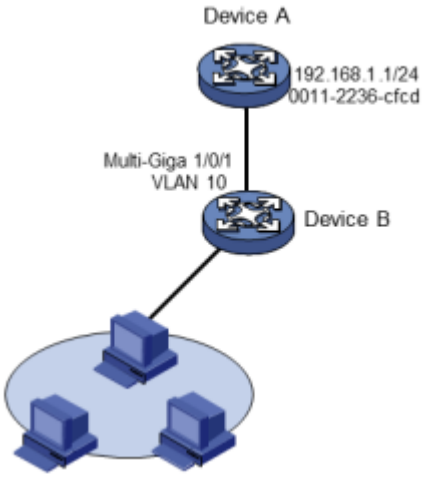

図 1-3 ネットワーク図

II. 設定手順

VLAN 10 を作成します。

```
<Switch> system-view
[Switch] vlan 10
[Switch-vlan10] quit
```

Multi-GigabitEthernet 1/0/1 に VLAN 10 を割り当てます。

```
[Switch] interface multi-GigabitEthernet 1/0/1
[Switch-Multi-GigabitEthernet1/0/1] port link-type access
[Switch-Multi-GigabitEthernet1/0/1] port access vlan 10
[Switch-Multi-GigabitEthernet1/0/1] quit
```

VLAN インタフェース 10 を作成し、IP アドレスを設定します。

```
[SwitchB] undo interface vlan-interface 1
[SwitchB] interface vlan-interface 10
[SwitchB-Vlan-interface10] ip address 192.168.1.2 8
[SwitchB-Vlan-interface10] quit
```

IP アドレス 192.168.1.1、MAC アドレス 0011-2236-cfcd、出力インタフェース VLAN 10 の Multi-GigabitEthernet 1/0/1 でスタティック ARP エントリを設定します。

```
[SwitchB] arp 192.168.1.1 0011-2236-cfcd
[SwitchB] mac-address-table static 0083-cc01-0203 vlan 10 interface
multi-GigabitEthernet 1/0/1
```

III. 設定の確認

Device B が Device A のスタティック ARP エントリを持っていることを確認します。

```
[SwitchB] display arp static
S - Static Entry
IP Address Hardware Addr IP Interface Age (min)
---------------- ---------------- ------------ ---------------
S 192.168.1.1 00-11-22-36-cf-cd forever
```

```
Total Entries: 1
[SwitchB]display mac-address-table static
VLAN MAC Address Type Ports
---- ----------------- ---------- -------------------------
10 0C-83-CC-7E-86-2C Static CPU
10 00-11-22-36-cf-cd Static multi1/0/1
Total Entries: 2
[SwitchB]
```

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2.1.2. Gratuitous ARP パケットの送信間隔の設定 2-1
2.2. 設定手順 2-2
2.3. IP 重複通知の有効化 2-3

2章 Gratuitous ARP

2.1. 概要

Gratuitous ARP パケットにおいて送信元 IP アドレスと宛先 IP アドレスは共に送信する装置の IP アドレスです。

装置は以下の目的で Gratuitous ARP パケットを送信します。

- 他のネットワーク装置と、IP アドレスが重複していないかを確認できます。もし IP アドレスが既に使われていた場合、ARP 応答によって重複していることが通知されます。
- 他のネットワーク装置に MAC アドレス情報を通知して、ARP エントリを更新させます。

2.1.1. Gratuitous ARP パケットの学習

Gratuitous ARP パケットの学習機能を有効にした場合、Gratuitous ARP パケットを受信すると、受信した Gratuitous ARP パケットの送信元 IP アドレスと MAC アドレスを使用して ARP エントリを作成あるいは更新します。

この機能を無効にした場合、ARP エントリの更新は行いますが、新しい ARP エントリは追加しません。ARP エントリは受信した Gratuitous ARP パケットをもとに ARP エントリを作成しないで、ARP テーブルを節約します。

2.1.2. Gratuitous ARP パケットの送信間隔の設定

定期的に Gratuitous ARP パケットを送信することにより、下流の装置の対応する ARP エントリあるいは MAC アドレスエントリを定期的に更新します。

この機能により以下の機能をサポートします。

- ゲートウェイ スプーフィングの防御

  攻撃者がネットワーク上のホストに捏造した Gratuitous ARP パケットを送信するためにゲートウェイアドレスを使用したとき、ゲートウェイスプーフィングが発生します。ホストからゲートウェイ宛のトラフィックは代わりに攻撃者に送信されます。その結果ホストは外部のネットワークにアクセスできません。

  ゲートウェイスプーフィングの攻撃を防ぐため、ゲートウェイが Gratuitous ARP パケットを送信する間隔を設定することができます。Gratuitous ARP パケットは、ホストが正しいゲートウェイの情報を学習できるように、ゲートウェイのプライマリ IP アドレスと手動で設定されたセカンダリ IP アドレスが含まれます。

- ARP エントリのエージアウトの防止

  ネットワークのトラフィックが非常に多い、あるいはホストの CPU の使用率が高い場合、受信した ARP パケットは廃棄、あるいはすぐに処理されません。そのため、受信ホストのダイナミック ARP エントリはエージアウトします。ホストと対応する装置間のトラフィックは、ホストが ARP エントリを再作成するまで中断されます。

この問題を防ぐため、定期的に Gratuitous ARP パケットを送信するゲートウェイを有効にします。受信ホストはすぐに ARP エントリをアップデートすることができます。

- ホストが使用する VRRP グループの仮想 IP アドレスの防止

  VRRP グループのマスタルータは定期的にローカルネットワークのホストに Gratuitous ARP パケットを送信することができます。ホストはローカルの ARP エントリをアップデートし、VRRP グループの仮想 IP アドレスを使用することを防ぎます。Gratuitous ARP パケットの送信者の MAC アドレスは仮想ルータの仮想 MAC アドレスです。

2.2. 設定手順

Gratuitous ARP を設定する際は、以下の制限事項とガイドラインに従ってください。

- 最大 1024 のインタフェースで Gratuitous ARP パケットの送信間隔を設定できます。
- Gratuitous ARP パケットの送信間隔の設定は、以下の状態の場合に適用されます。
  - インタフェースのリンク状態がアップです。
  - IP アドレスが割り当てられています。
- Gratuitous ARP パケットの送信間隔を変更する場合、設定は次の送信間隔から適用されます。
- Gratuitous ARP パケットの送信間隔は以下の状況によって、設定した値よりも長くなる可能性があります。
  - 複数のインタフェースで有効にされた場合
  - 各インタフェースで複数のセカンダリ IP アドレスが設定された場合
  - 前の 2 つの条件が存在する場合、Gratuitous ARP パケットの送信間隔は設定された送信間隔よりも短くなります。

以下に Gratuitous ARP の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. Gratuitous ARP パケット学習機能を有効にする	**gratuitous-arp-learning enable**	デフォルト：無効
3. 送信元 IP アドレスが別のサブネットに属する ARP 要求を受信した際に、装置が Gratuitous ARP パケットの送信を有効にする	**ip gratuitous-arps**	デフォルト：無効
4. interface view に移行する	**interface** *interface-id*	―
5. Gratuitous ARP パケットの定期的な送信を有効にし、送信間隔を設定する	**arp send-gratuitous-arp** [**interval** *interval*]	デフォルト：無効

2.3. IP重複通知の有効化

デフォルトで、受信装置が Gratuitous ARP パケットの送信者の IP アドレスを使用する場合、受信装置は gratuitous ARP 要求を送信します。重複に関する ARP 応答を受信したのち、エラーメッセージを表示します。

このコマンドを使用することで、Gratuitous ARP 応答あるいは要求を送信することなく、装置でエラーメッセージを表示することができます。

以下に IP 重複通知の有効化の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	ー
2. IP 重複通知を有効にする	**ip gratuitous-arps** [**dad-reply**]	デフォルト：無効

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3.1.2. 特殊な IP アドレス 3-2
3.1.3. サブネットとマスク 3-2
3.2. インタフェースへの IP アドレスの割り当て 3-3
3.3. IP アドレスの表示と維持 3-3
3.4. IP アドレスの設定例 3-4

3章 IP アドレス

この章の IP アドレスは、特に指定がない限り、IPv4 アドレスについて記載します。

本章では、IP アドレスの基本とインタフェースへの手動での IP アドレス割り当てについて説明します。ダイナミック IP アドレス割り当て（BOOTP および DHCP）は本章の範囲外です。

3.1. 概要

この章では、IP アドレスの基本について説明します。

IP アドレスは、IPv4 ネットワークの各ホストを識別するため、32 ビットアドレスを使用します。たとえば、2 進数では 00001010000000010000000100000001 となります。IP アドレスをわかりやすくするために、32 ビットの整数値を 8 ビットずつ 4 つに分割し、ドット付きの 10 進数で IP アドレスを表します。先ほどの 32 ビットの 2 進数は、10.1.1.1 となります。

3.1.1. IP アドレスクラス

各 IP アドレスは以下のセクションに分類されます。

- **Net ID** – ネットワークを定義します。先頭の数ビットはネットワークを定義するアドレスです。クラスフィールドあるいはクラスビットで、IP アドレスのクラスを識別します。
- **Host ID** – ホストを定義します。

図 3-1 に示すように、IP アドレスは 5 つのクラスに分類されます。IP アドレスがどのクラスに所属するのかは、下図の青い部分のアドレスによって決まります。最初の 3 つのクラスは一般的に使用されます。

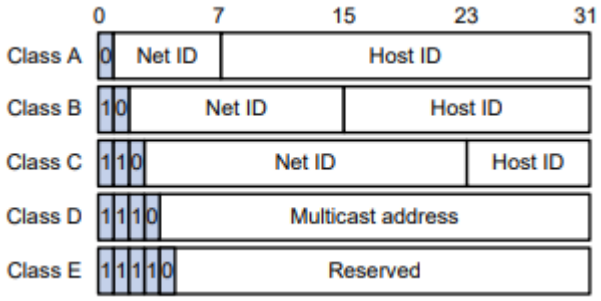

図 3-1 IP アドレスクラス

表 3-1 IP アドレスクラスと範囲

クラス	アドレス範囲	補足
A	0.0.0.0～127.255.255.255	IPアドレス0.0.0.0は、ブートストラップ時に一時的にホストが使用するため、有効な宛先アドレスにはなりません。 127からはじまるアドレスはループバックテ

クラス	アドレス範囲	補足
		ストのために予約されているため、このアドレス宛てのパケットは、入力パケットとしてローカルで処理されます。
B	128.0.0.0 ～ 191.255.255.255	—
C	192.0.0.0 ～223.255.255.255	—
D	224.0.0.0～ 239.255.255.255	マルチキャストアドレス
E	240.0.0.0 ～ 255.255.255.255	予約済みです。255.255.255.255はブロードキャストアドレスです。

3.1.2. 特殊な IP アドレス

以下の IP アドレスは特別な用途で使用されるため、ホストの IP アドレスに設定することができません。

- **Net ID がすべて 0 の IP アドレス** – ローカルネットワークのホストを識別します。たとえば、IP アドレス 0.0.0.16 はローカルネットワークの Host ID が 16 のホストを示します。
- **Host ID がすべて 0 の IP アドレス** –ネットワークアドレスを示します。
- **Host ID がすべて 1 の IP アドレス** – ディレクテッドブロードキャストを示します。たとえば、宛先アドレスが 192.168.1.255 のパケットは、ネットワーク 192.168.1.0 に属するすべてのホストにブロードキャストされます。

3.1.3. サブネットとマスク

サブネットは、Host ID のいくつかのビットを使用して Subnet ID を作成し、ネットワークをサブネットと呼ばれるより小さいネットワークに分割します。

Host ID と、Net ID と Subnet ID の組み合わせの境界を識別するために、サブネットマスクが使用されます。

各サブネットマスクは IP アドレス関連する 32 ビットで構成されています。サブネットマスクは 1 と 0 で構成されています。1 が連続している部分で Net ID と Subnet ID の組み合わせを識別し、0 が連続している部分で Host ID を識別します。

サブネットとなるまえに、クラス A、B、C ネットワークは、それぞれ 255.0.0.0、255.255.0.0、255.255.255.0 のデフォルトマスク（ナチュラルマスクと呼ばれます）を使用します。

I. クラス B ネットワークのサブネット分割

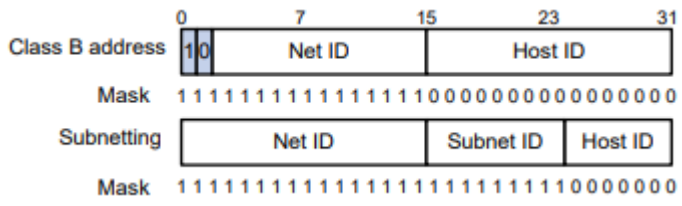

図 3-2 クラス B ネットワークのサブネット分割

サブネットは、ホストに割り当てることができないアドレスを増大させます。従って、サブネットを使用することは、ある程度少ないホストを適用することになります。

例えば、サブネットがないクラス B ネットワークは、同じネットワークを 512 のサブネットに分割した場合よりも、1022 台多くのホストを収容できます。

- **サブネットがないネットワーク** – 65534 個 ($2^{16}-2$) のホストを収容できます。(Host ID がすべて 1 のブロードキャストアドレスと、Host ID すべて 0 のネットワークアドレスを差し引きます。)
- **サブネットネットワーク** – Host-ID の最初の 9 ビットをサブネットに割り当てると、512 個 (2^9) のサブネットができます。Host-ID に使用できるのは残りの 7 ビットだけとなり、各サブネットに 126 個 (2^7-2) のホストを収容できます。従って、全部で 64512 個 (512×126) のホストを収容できます。

3.2. インタフェースへのIPアドレスの割り当て

インタフェースは他のホストと通信するために IP アドレスが必要です。手動でインタフェースに IP アドレスを割り当てるか、DHCP によって IP アドレスを取得することができます。IP アドレスを取得する方法を変更した場合、新しい IP アドレスは古い IP アドレスに上書きします。

I. 制限とガイドライン

インタフェースに IP アドレスを割り当てる際は、以下のガイドラインに従ってください。

- インタフェースは 1 つのプライマリ IP アドレスのみを設定することができます。新しく IP アドレスを設定した場合、古いアドレスが上書きされます。

II. 設定手順

以下にインタフェースへの IP アドレスの割り当てを示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. interface view に移行する	**interface** *iinterface-id*	—
3. インタフェースに IP アドレスを設定する	**ip address** { *ip-address* { *mask-length* | *subnet-mask* } | **dhcp** }	デフォルト：設定なし

3.3. IPアドレスの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
指定した、またはすべてのレイヤ3インタフェースのIP設定と統計情報を表示する	**display ip interface** [*interface-type interface-number*]
レイヤ3インタフェースの概要IP情報を表示する	**display ip interface** [*interface-id*] **brief**

3.4. IPアドレスの設定例

I. ネットワーク要件

図 3-3 に示すように、Switch 上の VLAN 1 は、IP アドレス 172.16.1.0/24 の LAN に接続されています。

ネットワーク上の Host が Switch 経由で外部ネットワークと通信可能するには、以下の手順を実行します。

- Switch の VLAN インタフェース 1 に IP アドレスを割り当てます。
- サブネット 172.16.1.0/24 の PC のゲートウェイアドレスとして、Switch の IP アドレスを設定します。

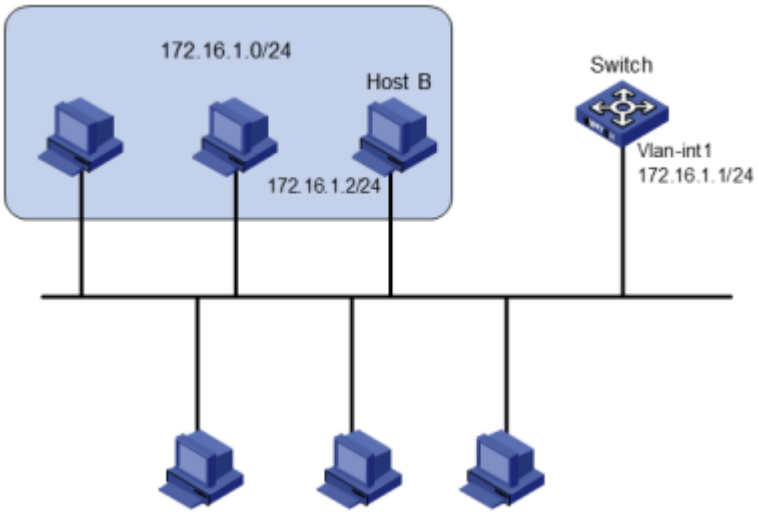

図 3-3 ネットワーク図

II. 設定手順

VLAN インタフェース 1 に IP アドレスを割り当てます。

```
<Switch> system-view
[Switch] interface vlan-interface 1
[Switch-Vlan-interface1] ip address 172.16.1.1 24
[Switch-Vlan-interface1] return
```

サブネット 172.16.1.0/24 に接続された PC のゲートウェイアドレスを 172.16.1.1 に設定します。

III. 設定の確認

サブネット 172.16.1.0/24 上の Host と Switch 間の接続性を確認します。

```
<Switch> ping 172.16.1.2
PING 172.16.1.2 (172.16.1.2) 56(84) bytes of data.
64 bytes from 172.16.1.2: icmp_seq=1 ttl=128 time=0.993 ms
64 bytes from 172.16.1.2: icmp_seq=2 ttl=128 time=1.10 ms
64 bytes from 172.16.1.2: icmp_seq=3 ttl=128 time=1.33 ms
64 bytes from 172.16.1.2: icmp_seq=4 ttl=128 time=1.22 ms
```

```
64 bytes from 172.16.1.2: icmp_seq=5 ttl=128 time=5.40 ms
64 bytes from 172.16.1.2: icmp_seq=6 ttl=128 time=1.10 ms
--- 172.16.1.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5006ms
rtt min/avg/max/mdev = 0.993/1.857/5.401/1.588 ms
```

目次

このセクションのページは**3-x-x** です。

4 章 DHCP クライアント 4-1
4.1. インタフェースでの DHCP クライアントの有効化 4-1
4.2. DHCP クライアント設定例 4-1

4章 DHCP クライアント

DHCP クライアントが有効である場合、インタフェースは、DHCP を使用して DHCP サーバから IP アドレスなどの設定パラメータを取得します。DHCP クライアントの設定は VLAN インタフェースでのみサポートします。

4.1. インタフェースでのDHCPクライアントの有効化

インタフェースで DHCP クライアントを有効にするため、以下のガイドラインに従ってください。

- DHCP クライアントが有効になったインタフェースはセカンダリ IP アドレスを設定することができません。

以下にインタフェースでの DHCP クライアントの有効化の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. interface view に移行する	**interface** *interface-id*	—
3. インタフェースで DHCP クライアントを有効にする	**ip address dhcp**	デフォルト：無効

4.2. DHCPクライアント設定例

I. ネットワーク要件

図 4-1 に示すように､LAN で Switch B は VLAN インタフェース 2 を通して DHCP サーバと接続し、IP アドレス、DNS サーバアドレス、スタティックルート情報を取得します。DHCP クライアントのアドレスはネットワーク 10.1.1.0/24 にあり、DNS サーバアドレスは 20.1.1.1、スタティックルートの 20.1.1.0/24 のネットワークのネクストホップアドレスは、10.1.1.2 です。

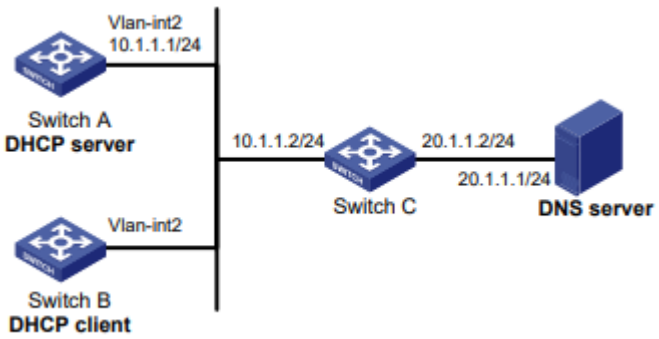

図 4-1 ネットワーク図

II. 設定手順

1. DHCP サーバを設定します。

> 🕮 メモ：
> QX-S900M は DHCP 機能をサポートしていません。以下の例は、この機能をサポートする別のスイッチで必要な DHCP サーバ設定を行う方法を示しています。

VLAN インタフェース 2 の IP アドレスを指定します。

```
Switch# configure terminal
Switch(config)# interface vlan 2
Switch(config-if)# ip address 10.1.1.1 255.255.255.0
Switch(config-if)# exit
```

DHCP アドレスプール 0 を設定します。サブネット、リース期間、DNS サーバアドレス、およびサブネット 20.1.1.0/24 へのスタティックルートを指定します。

```
Switch(config)# ip dhcp pool 1
Switch(config-dhcp-pool)# network 10.1.1.0 255.255.255.0
Switch(config-dhcp-pool)# lease 10 0 0
Switch(config-dhcp-pool)# dns-server 20.1.1.1
```

ダイナミック割り当てから IP アドレスを除外します。

```
Switch(config)# ip dhcp excluded-address 10.1.1.1 10.1.1.2
```

DHCP を有効化します。

```
Switch(config)# service dhcp
```

2. Switch B を設定します。

VLAN インタフェース 2 を DHCP で IP アドレスを取得するように設定します。

```
<Switch> system-view
[Switch] interface vlan 2
[Switch-Vlan-interface2] ip address dhcp
[Switch-Vlan-interface2] return
```

III. 設定の確認

Switch B に割り当てられた IP アドレスおよびその他のネットワークパラメータを表示します。

```
<Switch> display ip interface
Interface vlan2 is enabled, Link status is up
 IP Address is 10.1.1.3/24 (DHCP)
 ARP timeout is 240 minutes.
 gratuitous-send is disabled, interval is 0 seconds
Total Entries: 1
<Switch> display dns server
Dynamic dns server:
20.1.1.1
Static dns server:
<Switch>
```

目次

このセクションのページは**3-x-x** です。

5 章 DNS 5-1
5.1. 概要 5-1
5.2. DNS 設定作業リスト 5-1
5.3. IPv4 DNS クライアントの設定 5-1
5.3.1. ドメイン名解決の設定 5-1
5.4. DNS の表示と維持 5-2
5.5. IPv4 DNS 設定例 5-2
5.5.1. ドメイン名解決の設定例 5-2

5章 DNS

5.1. 概要

DNS(Domain Name System)は TCP/IP アプリケーションで使用する分散データベースで、ドメイン名を対応する IP アドレスに変換します。ドメイン名－IP アドレスのマッピングは DNS エントリと呼ばれます。

5.2. DNS設定作業リスト

作業リスト
以下のタスクを実行します。 • IPv4 DNS クライアントの設定

5.3. IPv4 DNSクライアントの設定

5.3.1. ドメイン名解決の設定

ドメイン名解決を使用する場合、正しいサーバに DNS クエリを送信できるように DNS サーバを設定します。DNS サーバの設定方法は 2 つあります。手動で設定する方法と、DHCP 経由で取得する方法です。DHCP 経由で取得した DNS サーバは、手動で設定したサーバよりも優先されます。DHCP 経由で取得した DNS 情報は、DHCP または DHCPv6 のいずれかから取得され、DHCPv6 は DHCP よりも優先されます。

ネームクエリは 2 回試行されます。最初の試行はプライマリ DNS サーバに送信されます。応答がない場合、セカンダリ DNS サーバに送信されます。両サーバとも応答しない場合、2 回目のクエリが開始されます。2 回目も失敗した場合、クエリ全体は失敗と見なされます。

I. 制限とガイドライン

ドメイン名解決を設定する際は、以下のガイドラインに従ってください。

- DNS サーバの IPv4 アドレスは以下のように指定できます。
  - パブリックネットワーク用の DNS サーバ IPv4 アドレスを指定します。
  - パブリックネットワーク用に最大 3 つの DNS サーバ IPv4 アドレスを指定します。

II. 設定手順

以下にドメイン名解決の設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—

操作	コマンド	補足
2.　DNS サーバを設定する	DNSサーバのIPv4アドレスを設定する **dns server** *ip-address*	デフォルト：設定なし

5.4. DNSの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
IPv4 DNS サーバ情報を表示する	**display dns server**

5.5. IPv4 DNS設定例

5.5.1. ドメイン名解決の設定例

I. ネットワーク要件

図 5-1 に示すように、Host のドメイン名 host.com と Host の IPv4 アドレス 2.1.1.3/16 のマッピングを DNS サーバに記録するように設定します。Device がドメイン名 host.com を使用して Host にアクセスできるように、Device に IPv4 DNS サーバアドレスを設定します。

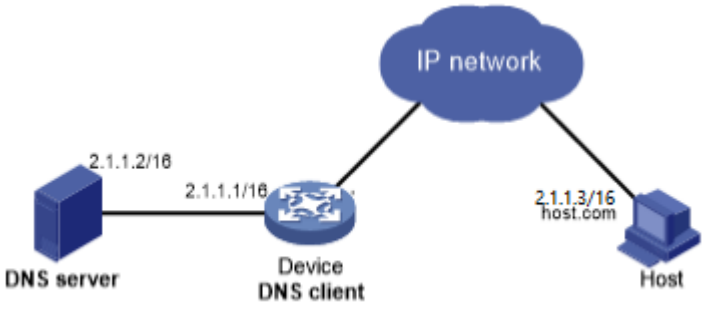

図 5-1 ネットワーク図

II. 設定手順

以下の設定を行う前に、以下のことを確認してください。

- Device と Host が互いに通信可能できることを確認してください。
- インタフェースの IP アドレスが図のように設定されていることを確認してください。

1. DNS サーバを設定します。以下の設定例は Linux での設定です。

- name.conf.local にホスト名と IP アドレス: host.com 2.1.1.3 を追加します。
- ネームサーバアドレス 2.1.1.2 を追加します。
- Linux を再起動します。

```
/etc/init.d/bind9 restar
```

- DNS サーバを再起動します。

```
sudo service bind9 restart
```

- DNS サーバを確認します。

```
sudo service bind9 status
```

2. DNS クライアントを設定します。

DNS サーバを 2.1.1.2 に指定します。

```
<Switch> system-view
[Switch] dns server 2.1.1.2
```

III. 設定の確認

Device がドメイン名解決を使用してドメイン名 host.com を IP アドレス 2.1.1.3 に解決できることを確認します。

```
<Switch> ping host.com
PING host (2.1.1.3) 56(84) bytes of data.
64 bytes from 2.1.1.3: icmp_seq=1 ttl=128 time=1.67 ms
64 bytes from 2.1.1.3: icmp_seq=2 ttl=128 time=0.669 ms
64 bytes from 2.1.1.3: icmp_seq=3 ttl=128 time=0.740 ms
64 bytes from 2.1.1.3: icmp_seq=4 ttl=128 time=0.647 ms
64 bytes from 2.1.1.3: icmp_seq=5 ttl=128 time=0.671 ms
64 bytes from 2.1.1.3: icmp_seq=6 ttl=128 time=0.622 ms
64 bytes from 2.1.1.3: icmp_seq=7 ttl=128 time=0.722 ms
--- host.com ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6122ms
rtt min/avg/max/mdev = 0.622/0.819/1.666/0.347 m
```

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

4. IP ルーティング

本マニュアルは以下に示す章で構成されています。

01-スタティックルーティング
02-デフォルトルート

目次

このセクションのページは **4-x-x** です。

1章 スタティックルーティング ····· 1-1
1.1. スタティックルートの設定 ····· 1-1
1.2. スタティックルートの表示と維持 ····· 1-1
1.3. スタティックルートの設定例 ····· 1-2
1.3.1. 基本的なスタティックルートの設定例 ····· 1-2

1章 スタティックルーティング

スタティックルートは手動で設定します。ネットワークの構成が簡単であれば、スタティックルートの設定だけで問題なく運用することができます。

ただし、ネットワーク障害やトポロジの変化が起きた場合、ネットワーク管理者がスタティックルートを修正する必要があります。

1.1. スタティックルートの設定

スタティックルートの設定を行う前に以下の設定が完了していることを確認してください。

- 関連インタフェースの物理パラメータの設定
- 関連インタフェースのリンクレイヤの設定
- 関連インタフェースの IP アドレスの設定

以下にスタティックルートの設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. スタティックルートを設定する	**ip route-static** *network-prefix* { *mask-len* | *mask* } { *ip-address* [**primary** | **backup**] }	デフォルト：設定なし
3. (オプション設定項目) スタティックデフォルトルートのデフォルトを設定する	**distance default** *distance*	デフォルト：1
4. (オプション設定項目) スタティックルートのデフォルトプリファレンスを設定する	**distance static** *distance*	デフォルト：60

1.2. スタティックルートの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
スタティックルート情報を表示する	**display ip route** [[*ip-address* [*mask-len* | *mask*] | *protocol*] | **hardware**]

1.3. スタティックルートの設定例

1.3.1. 基本的なスタティックルートの設定例

I. ネットワーク要件

図 1-1 に示すように、2 つのホスト間で相互接続できるように、スイッチでスタティックルートを設定します。

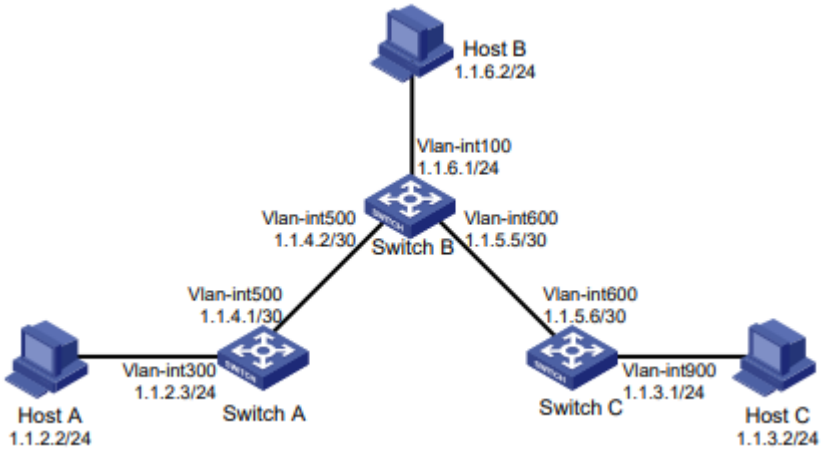

図 1-1 ネットワーク図

II. 設定手順

1. インタフェースの IP アドレスを設定します。(詳細は省略します)
2. スタティックルートを設定します。

   # Switch A にデフォルトルートを設定します。

```
<SwitchA> system-view
[SwitchA] ip route-static 0.0.0.0 0.0.0.0 1.1.4.2
```

   # Switch B に 2 つのスタティックルートを設定します。

```
<SwitchB> system-view
[SwitchB] ip route-static 1.1.2.0 255.255.255.0 1.1.4.1
[SwitchB] ip route-static 1.1.3.0 255.255.255.0 1.1.5.6
```

   # Switch C にデフォルトルートを設定します。

```
<SwitchC> system-view
[SwitchC] ip route-static 0.0.0.0 0.0.0.0 1.1.5.5
```

3. Host A、Host B、Host C のデフォルトゲートウェイをそれぞれ 1.1.2.3、1.1.6.1、1.1.3.1 に設定します。(詳細は省略します)

III. 設定の確認

Switch A のスタティックルートを表示します。

```
[SwitchA] display ip route static
S 0.0.0.0/0 via 1.1.4.2, vlan500
# Display static routes on Switch B.
[SwitchB] display ip route static
S 1.1.2.0/24 via 1.1.4.1, vlan500
S 1.1.3.0/24 via 1.1.5.6, vlan600
```

Host B で **ping** コマンドを使用し、Host A への接続を確認します。（2 つのホストは Windows XP で動作していると仮定します。）

```
C:\Documents and Settings\Administrator> ping 1.1.2.2
Pinging 1.1.2.2 with 32 bytes of data:
Reply from 1.1.2.2: bytes=32 time=1ms TTL=126
Reply from 1.1.2.2: bytes=32 time=1ms TTL=126
Reply from 1.1.2.2: bytes=32 time=1ms TTL=126
Reply from 1.1.2.2: bytes=32 time=1ms TTL=126
Ping statistics for 1.1.2.2:
 Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
 Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

Host B で **tracert** コマンドを使用し、Host A への接続を確認します。

```
C:\Documents and Settings\Administrator> tracert 1.1.2.2
Tracing route to 1.1.2.2 over a maximum of 30 hops
 1 <1 ms <1 ms <1 ms 1.1.6.1
 2 <1 ms <1 ms <1 ms 1.1.4.1
 3 1 ms <1 ms <1 ms 1.1.2.2
Trace complete.
```

目次

このセクションのページは **4-x-x** です。

2 章 デフォルトルート 2-1

2章　デフォルトルート

デフォルトルートはルーティングテーブルの指定したルーティングエントリにマッチしないパケットを転送するのに使用されます。デフォルトルートが設定されていない場合、ルーティングエントリにマッチしないパケットは廃棄されます。

デフォルトルートは以下の方法で設定できます。

- デフォルトルートはネットワーク管理者が宛先アドレスとマスクを 0.0.0.0 に設定します。

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

5. ACL and QoS

本マニュアルは以下に示す章で構成されています。

01-ACL

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1章 ACL

1.1. 概要

ACL(Access Control List)は、ルール(許可または拒否ステートメント)の設定で、送信元 IP アドレス、宛先 IP アドレス、ポート番号などにマッチするルールに従って、どのパケット処理するかを決定します。

ACL は主にパケットフィルタリングに使用されます。「ACL へのパケットフィルタの設定」で例を示します。ACL は QoS、セキュリティ、その他の機能でトラフィックの設定に使用できます。ACL を使用して、モジュールにおけるパケットの廃棄、転送を決定します。

1.1.1. ACL タイプ

タイプ	ACL 番号	マッチング基準
標準IP ACL	1～1999	送信元IP（任意、ホスト、ワイルドカード）、オプションの宛先IP（任意、ホスト、ワイルドカード）
拡張IP ACL	2000～3999	送信元IP、宛先IP、プロトコル（TCP、UDP、ICMP、その他）、TCP/UDPポート（演算子、範囲、マスク）、ICMPタイプ/コード、TCPフラグ、フラグメント、優先度、TOS、DSCP
標準IPv6 ACL	11000～12999	送信元IPv6（任意、ホスト、プレフィックス）、オプションの宛先IPv6（任意、ホスト、プレフィックス）
拡張IPv6 ACL	13000～14999	送信元IPv6、宛先IPv6、プロトコル（TCP、UDP、ICMP、ESP、PCP、SCTP、プロトコルID）、TCP/UDPポート（等価、マスク）、TCPフラグ、ICMPタイプ/コード、DSCP、トラフィッククラス、フローラベル
MAC ACL	6000～7999	送信元MAC、宛先MAC、イーサネットタイプ、CoS、VLAN ID
エキスパートACL	8000～9999	送信元IP、宛先IP、送信元MAC、宛先MAC、プロトコル（TCP、UDP、ICMP、その他）、TCP/UDPポート（演算子、範囲、マスク）、TCPフラグ、ICMPタイプ/コード、CoS、VLAN ID、フラグメント、優先度、TOS、DSCP

🕮 メモ:

ハードウェアベースの ACL（QoS, packet-filter など）は暗黙の permit となり、ソフトウェアベースの ACL（telnet, snmp など）は暗黙の deny になります。

1.1.2. ACL の番号付けと命名

各 ACL のタイプには、ACL 番号の固有な範囲があります。ACL を作成するとき、固有の ACL 番号あるいは名前を付ける必要があります。識別を簡略化するために ACL の名前を割り当てることができます。

標準 IPv4 ACL と拡張 IPv4 ACL では、IPv4 で一意の ACL 番号と名前を使用する必要があります。標準 IPv6 ACL と拡張 IPv6 ACL では、IPv6 で一意の ACL 番号と名前を使用する必要があります。その他のタイプの ACL の場合、番号または名前はグローバルに一意である必要があります。

1.1.3. 走査順

ACL のルールは指定された順序で探索されます。パケットが、あるルールにマッチした時点で探索動作を終了し、そのルールで定義されたアクションを実行します。インバースマスク（inverse mask）と呼ばれるワイルドカードマスクは、10 進数表示のドット表示で表される 32 ビットバイナリです。ネットマスクの 0 は“一致する（do care）”ビットと表現され、1 は“無視する（don't care）”ビットと表現されます。サブネットマスクの 0 と 1 を反転したものとは異なります。IP アドレスが“do care”ビットである場合、一致させ、“無視する（don't care）”ビットである場合、無視されます。ワイルドマスクが 0.255.255.255、ネットマスクが 192.168.1.1 の場合、最初の 0 は”一致する（do care）"ビットで、2 番目以降が“無視する（don't care）”ビットであるため、192.0.0.0 のネットワークに一致する ACL となります。ワイルドカードマスクの 0 と 1 は非連続にすることができます。たとえば 0.255.0.255 は有効なワイルドマスクです。

1.1.4. ルールナンバリング

ACL ルールは手動ナンバリングあるいは自動ナンバリングを選択できます。本セクションでは自動ナンバリングの動作を説明します。

I. ルールナンバリングのステップ

シーケンス番号なしでルールエントリを作成した場合、シーケンス番号が自動的に割り当てられます。最初のエントリである場合、シーケンス番号 10 が割り当てられます。以降のエントリには、アクセスリスト内の最大シーケンス番号より 10 大きいシーケンス番号が割り当てられ、リストの末尾に配置されます。

隣接したナンバリングルールより、ルールの間に隙間を導入することによって、新規にルールを挿入するように、ACL に柔軟性を持たせることができます。この機能は config-order ACL にとって重要です。

II. 自動ルールナンバリングと再ナンバリング

acl resequence コマンドは、指定されたアクセスリストの開始シーケンス番号と増分を変更します。

コマンド適用後、シーケンス番号が指定されていない新規ルールは、新しいシーケンス設定に従って割り当てられます。シーケンス番号を手動で割り当てる場合、将来の低い番号用に間隔を予約しておくことを推奨します。これによりエントリ挿入時の余分な手間を回避できます。各シーケンス番号は ACL 内で一意である必要があります。既に存在するシーケンス番号を使用しようとすると、エラーメッセージが表示されます。

1.1.5. ACL でのフラグメントフィルタリング

通常のパケットフィルタリングはパケットの最初のフラグメントのみマッチし、後続のフラグメントはパスします。攻撃者はネットワークを攻撃するため、最初でないフラグメントを偽造することができます。

このリスクを防ぐため、以下の ACL を使用します。

- デフォルトで、最初のフラグメント以外のパケットを含むすべてのフラグメントをフィルタします。
- マッチ条件の変更を行います。たとえば、最初のフラグメント以外のパケットのみをフィルタします。

1.2. ACL設定の制限事項とガイドライン

ACL 番号または ASL 名が付いた ACL を作成するには、以下のいずれかのコマンドを使用できます。

- **ip acl** [**extended**] *name* [*number*]
- **ipv6 acl** [**extended**] *name* [*number*]
- **mac acl extended** *name* [*number*]
- **expert acl extended** *name* [*number*]

1.3. 設定作業リスト

作業リスト

(必須設定項目) マッチング対象パケットの特性に応じてACLを設定します。
• 標準 ACL の設定
  ○ 標準 IP ACL の設定
  ○ 標準 IPv6 ACL の設定
• 拡張 ACL の設定
  ○ 拡張 IP ACL の設定
  ○ 拡張 IPv6 ACL の設定
• MAC ACL の設定
• エキスパート ACL の設定

(オプション設定項目) ACLへのパケットフィルタの設定

1.4. 標準ACLの設定

この章では、標準 ACL の設定方法について説明します。

1.4.1. 標準 IP ACL の設定

標準 IP アクセス制御リスト（ACL）は、より単純な条件セットを使用します。送信元 IP アドレスのみを照合し、任意のアドレス、ホストアドレス、またはワイルドカードマスク付きアドレスを使

用します。オプションで宛先アドレスも同様の形式で照合できますが、プロトコルやポートレベルのフィルタリングはサポートしていません。

以下に標準 IP ACL の設定方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. 標準 IP ACL を作成し、その view に移行する	**ip acl** *name* [*number*]	デフォルト：設定なし 設定範囲は1～1999 です。
3. (オプション設定項目) ACL の説明を設定する	**list-remark** *text*	デフォルト：設定なし
4. ルールを作成/修正する	**rule** [*sequence-number*] { permit | **deny** { **any** | **host** *src-ipaddr* | *src-ip-addr src-ip-wildcard* } [**any** | **host** *dst-ip-addr* | *dst-ip-addr dst-ip-wildcard*]	デフォルト：設定なし

1.4.2. 標準 IPv6 ACL の設定

標準 IPv6 ACL はより簡素な一致条件セットを使用します。送信元 IPv6 アドレスのみでフィルタリングし、任意の宛先 IPv6 アドレス、ホストアドレス、またはプレフィックスをオプションで一致させることができます。

サポートプロトコル、ポート、または高度なヘッダマッチングを提供し、IPv6 トラフィックをフィルタリングする基本的な方法を提供します。

以下に標準 IPv6 ACL の設定方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. 標準 IPv6 ACL を作成し、その view に移行する	**ipv6 acl** *name* [*number*]	デフォルト：設定なし 設定範囲は11000～12999です。
3. （オプション設定項目）ACL の説明を設定する	**list-remark** *text*	デフォルト：設定なし
4. ルールを作成/修正する	**rule** [*sequence-number*] { **permit** | **deny** } { **any** | **host** *src-ipv6-addr* | *src-ipv6-addr/prefix-length* } [**any** | **host** *dst-ipv6-addr* | *dst-ipv6-addr/prefix-length*]	デフォルト：設定なし

1.5. 拡張ACLの設定

この章では、拡張アクセス制御リスト（Extended ACL）の設定方法について説明します。

1.5.1. 拡張 IP ACL の設定

拡張 IP ACL は、幅広いフィールドで一致させることができます。送信元および宛先 IP アドレス、トランスポートプロトコル、TCP、UDP、ICMP、その他の IP プロトコルなどの特定のプロトコルタイプによるフィルタリングが可能です。また、演算子、範囲、またはマスク付きマッチングを使用した TCP および UDP のポートベースフィルタリングもサポートしています。追加のマッチングオプションには、ICMP タイプとコード、TCP フラグ、パケットフラグメント、優先度、TOS、DSCP などのトラフィックマーキングが含まれます。

以下に拡張 IP ACL の設定方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. 拡張 IP ACL を作成し、その view に移行する	**ip acl extended** *name* [*number*]	デフォルト：設定なし 設定範囲は2000~3999 です。
3. （オプション設定項目）ACL の説明を設定する	**list-remark** *text*	デフォルト：設定なし
4. ルールを作成/修正する	**rule** [*sequence-number*] { **permit** | **deny** } **tcp** { **any** | **host** *src-ip-addr* | *src-ip-addr src-ip-wildcard* } [{ **eq** | **lt** | **gt** | **neq** } *port* | **range** *min-port max-port* | **mask** *port mask*] { **any** | **host** *dst-ip-addr* | *dst-ip-addr dst-ip-wildcard* } [{ **eq** | **lt** | **gt** | **neq** } *port* | **range** *min-port max-port* | **mask** *port mask*] [*tcp-flag*] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } **udp** { **any** | **host** *src-ip-addr* | *src-ip-addr src-ip-wildcard* } [{ **eq** | **lt** | **gt** | **neq** } *port* | **range** *min-port max-port* | **mask** *port mask*] { **any** | **host** *dst-ip-addr* | *dst-ip-addr dst-ip-wildcard* } [{ **eq** | **lt** | **gt** | **neq** } *port* | **range** *min-port max-port* | **mask** *port mask*] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } **icmp** { **any** | **host** *src-ip-addr* | *src-ip-addr src-ip-wildcard* } { **any** | **host** *dst-ip-addr* | *dst-ip-addr*	デフォルト：設定なし

操作	コマンド	補足
	dst-ip-wildcard} [*icmp-type* [*icmp-code*] | *icmp-message*] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } { **gre** | **esp** | **eigrp** | **igmp** | **ipinip** | **ospf** | **pcp** | **pim** | **vrrp** | **protocol-id** *protocol-id* [*mask*] } { **any** | **host** *src-ip-addr* | *src-ip-addr* *src-ip-wildcard*} { **any** | **host** *dst-ip-addr* | *dst-ip-addr* *dst-ip-wildcard*} [**fragments**] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } { **any** | **host** *src-ip-addr* | *src-ip-addr* *src-ip-wildcard*} [**any** | **host** *dst-ip-addr* | *dst-ip-addr* *dst-ip-wildcard*] [**fragments**] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]]	

1.5.2. 拡張 IPv6 ACL の設定

拡張 IPv6 アクセス制御リスト（ACL）は、幅広いフィールドで一致させることができます。送信元および宛先 IPv6 アドレスを、任意のアドレス、ホストアドレス、またはプレフィックスを使用してフィルタリングできます。TCP、UDP、ICMP、ESP、PCP、SCTP、プロトコル ID に基づくフィルタリングをサポートします。TCP および UDP では、ポート番号を等値比較（eq）またはマスク処理（masked port matching）で一致させることができます。追加オプションとして、TCP フラグ、ICMP タイプとコード、DSCP、トラフィッククラス、フローラベルがあり、それぞれにオプションのマスク処理を適用することで、トラフィック分類を精密に制御できます。

以下に拡張 IPv6 ACL の設定方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. 拡張 IPv6 ACL を作成し、その view に移行する	**ipv6 acl extended** *name* [*number*]	デフォルト：設定なし 設定範囲は13000～14999です。
3. (オプション設定項目) ACL の説明を設定する	**list-remark** *text*	デフォルト：設定なし

操作	コマンド	補足
4.　ルールを作成/修正する	**rule** [*sequence-number*] { **permit** | **deny** } **tcp** { **any** | **host** *src-ipv6-addr* | *src-ipv6-addr/prefix-length* } [{ **eq** } *port* | **mask** *port mask*] { **any** | **host** d*st-ipv6-addr* | *dst-ipv6-addr/prefix-length* } [{ **eq** } *port* | **mask** *port mask*] [*tcp-flag*] [**dscp** *value* [*mask*] | **traffic-class** *value* [*mask*]] [**flow-label** *flow-label* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } **udp** { **any** | **host** *src-ipv6-addr* | *src-ipv6-addr/prefix-length* } [{ **eq** } *port* | **mask** *port mask*] { **any** | **host** *dst-ipv6-addr* | *dst-ipv6-addr/prefix-length* } [{ **eq** } *port* | **mask** *port mask*] [**dscp** *value* [*mask*] | **traffic-class** *value* [*mask*]] [**flow-label** *flow-label* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } **icmp** { **any** | **host** *src-ipv6-addr* | *src-ipv6-addr/prefix-length* } { **any** | **host** *dst-ipv6-addr* | *dst-ipv6-addr/prefix-length* } [*icmp-type* [*icmp-code*] | *icmp-message*] [**dscp** *value* [*mask*] | **traffic-class** *value* [*mask*]] [**flow-label** *flow-labe*l [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } { **esp** | **pcp** | **sctp** | **protocol-id** *protocol-id* [*mask*] } { **any** | **host** *src-ipv6-addr* | *src-ipv6-addr/prefix-length* } { **any** | **host** *dst-ipv6-addr* | *dst-ipv6-addr/prefix-length* } [**dscp** *value* [*mask*] | **traffic-class** *value* [*mask*]] [**flow-label** *flow-label* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } { **any** | **host** *src-ipv6-addr* | *src-ipv6-addr/prefix-length* } [**any** | **host** *dst-ipv6-addr* | *dst-ipv6-addr/prefix-length*	デフォルト：設定なし

操作	コマンド	補足
	] [**dscp** *value* [*mask*] | **traffic-class** *value* [*mask*]] [**flow-label** *flow-label* [*mask*]]	

1.6. MAC ACLの設定

MAC ACL は、送信元および宛先 MAC アドレスを「any」またはホストアドレス、あるいはワイルドカードマスク付きアドレスで照合します。さらに、イーサネットタイプ、サービスクラス値、VLAN ID などのオプションフィールド（各々オプションのマスク付き）も使用可能です。ルールはシーケンス番号と permit/deny アクションで適用され、undo 形式ではシーケンス番号で特定のルールを削除します。

以下に MAC ACL の設定方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. MAC ACL を作成し、その view に移行する	**mac acl extended** *name* [*number*]	—
3. (オプション設定項目) ACL の説明を設定する	**list-remark** *text*	デフォルト：設定なし
4. ルールを作成/修正する	**rule** [*sequence-number*] { **permit** | **deny** } { **any** | **host** *src-mac-addr* | *src-mac-addr src-mac-wildcard* } { **any** | **host** *dst-mac-addr* | *dst-mac-addr dst-mac-wildcard* } [**ethernet-type** *type mask*] [**cos** *value* [*mask*]] [**vlan** *vlan-id* [*mask*]]	デフォルト：設定なし **logging**キーワードはモジュール(パケットフィルタリングなど)がサポートしている場合のみ機能します。

1.7. エキスパートACLの設定

エキスパート ACL は、複数のレイヤにわたる包括的なフィールドセットに基づいてトラフィックを照合できます。送信元および宛先 IP アドレス、送信元および宛先 MAC アドレス、TCP、UDP、ICMP を含むプロトコルタイプによるフィルタリングが可能です。TCP および UDP については、演算子、範囲、またはマスクを使用してポートをさらに照合できます。追加のマッチング基準には、TCP フラグ、ICMP タイプとコード、サービスクラス（CoS）、VLAN ID、パケットフラグメント、優先度、TOS、DSCP 値が含まれ、いずれもオプションのマスク設定によりトラフィックを細かく制御できます。各ルールは permit または deny アクションを持つシーケンス番号を使用し、ルールは undo sequence コマンドで削除可能です。

以下にエキスパート ACL の設定方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—

操作	コマンド	補足
2. エキスパート ACL を作成し、その view に移行する	**expert acl extended** *name* [*number*]	デフォルト：設定なし 設定範囲は8000～9999です。
3. (オプション設定項目) ACL の説明を設定する	**list-remark** *text*	デフォルト：設定なし
4. ルールを作成/修正する	**rule** [*sequence-number*] { **permit** | **deny** } *protocol* { *src-ip-addr* *src-ip-wildcard* | **host** *src-ip-addr* | **any** } { *src-mac-addr* *src-mac-wildcard* | **host** src-mac-addr | **any** } { *dst-ip-addr* *dst-ip-wildcard* | **host** *dst-ip-wildcard* | **any** } { *dts-mac-addr* *dst-mac-wildcard* | **host** *dst-mac-addr* | **any** } [**cos** *outer-cos* [*mask*]] [**vlan** *outer-vlan* [*mask*]] [**fragments**] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } **tcp** { *src-ip-addr* *src-ip-wildcard* | **host** *src-ip-addr* | **any** } { *src-mac-addr* *src-mac-wildcard* | **host** *src-mac-addr* | **any** } [{ **eq** | **lt** | **gt** | **neq** } *port* | **range** *min-port max-port* | **mask** *port mask*] { *dst-ip-addr* *dst-ip-wildcard* | **host** *dst-ip-addr* | **any** } { dst-mac-addr *dst-mac-wildcard* | **host** *dst-mac-addr* | **any** } [{ **eq** | **lt** | **gt** | **neq** } *port* | **range** *min-port max-port* | **mask** *port mask*] [*tcp-flag*] [**cos** *outer-cos* [*mask*]] [**vlan** *outer-vlan* [*mask*]] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } **udp** { *src-ip-addr* *src-ip-wildcard* | **host** *src-ip-addr* | **any** } { *src-mac-addr* *src-mac-wildcard* | **host** *src-mac-addr* | **any** } [{ **eq** |	デフォルト：設定なし

操作	コマンド	補足
	lt | **gt** | **neq** } *port* | **range** *min-port max-port* | **mask** *port mask*] { *dst-ip-addr dst-ip-wildcard* | **host** *dst-ip-addr* | **any** } { *dst-mac-addr dst-mac-wildcard* | **host** *dst-mac-addr* | **any** } [{ **eq** | **lt** | **gt** | **neq** } *port* | **range** *min-port max-port* | **mask** *port mask*] [**cos** *outer-cos* [*mask*]] [**vlan** *outer-vlan*] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]] **rule** [*sequence-number*] { **permit** | **deny** } **icmp** { *src-ip-addr src-ip-wildcard* | **host** *src-ip-addr* | **any** } { *src-mac-addr src-mac-wildcard* | **host** *src-mac-addr* | **any** } { *dst-ip-addr dst-ip-wildcard* | **host** *dst-ip-addr* | **any** } { *dst-mac-addr dst-mac-wildcard* | **host** *dst-mac-addr* | **any** } [*icmp-type* [*icmp-code*] | *icmp-message*] [**cos** *outer-cos* [*mask*]] [**vlan** *outer-vlan* [*mask*]] [[**precedence** *precedence* [*mask*]] [**tos** *tos* [*mask*]] | **dscp** *dscp* [*mask*]]	

1.8. ACLへのパケットフィルタの設定

この章では、ACL を使用してパケットをフィルタリングする手順について説明します。たとえば、インタフェースに ACL を適用して、受信または送信パケットをフィルタリングできます。

1.8.1. パケットフィルタリングのためのインタフェースへの ACL 適用

パケットフィルタリングのためにインタフェースに ACL を適用するには、以下のいずれかのコマンドを使用できます。

- **ip access-group** { *name* | *number* } [**in** | **out**]
- **ipv6 access-group** { *name* | *number* } [**in** | **out**]
- **mac access-group** { *name* | *number* } [**in** | **out**]
- **expert access-group** { *name* | *number* } [**in** | **out**]

これらのコマンドは物理ポート設定モードで使用可能です。インタフェースにアクセスグループが既に設定されている場合、後続のコマンドで以前の設定が上書きされます。同一タイプの ACL はインタフェースに 1 つしか適用できませんが、異なるタイプの ACL は同一インタフェースに適用可能です。アクセスグループをインタフェースに関連付けると、スイッチコントローラのフィルタリングエントリリソースを消費します。リソースが不足してコマンドをコミットできない場合、エラーメッセージが表示されます。

コマンドが正常に適用された場合、利用可能なエントリ数が表示されます。アクセスグループのルールにポート演算子（**gt** や **lt** など）が含まれる場合、残りのポート演算子数が表示されます。コマンドの適用により利用可能なポートセレクタが枯渇した場合、エラーメッセージが表示されます。

スイッチが同一ポートに QoS ポリシーと同一タイプの ACL の両方を適用する場合、QoS ポリシーが優先されます。

以下にパケットフィルタリングのためにインタフェースに ACL を適用する方法を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. interface view に移行する	**interface** *interface-type interface-number*	—
3. パケットをフィルタリングするためにインタフェースに ACL を適用する	標準/拡張IP ACLの場合: • **ip access-group** { *name* | *number* } [**in** | **out**] 標準/拡張 IPv6 ACL の場合: • **ipv6 access-group** { *name* | *number* } [**in** | **out**] MAC ACLの場合: • **mac access-group** { *name* | *number* } [**in** | **out**] エキスパートACLの場合: • **expert access-group** { *name* | *number* } [**in** | **out**]	デフォルト：設定なし

1.8.2. VLAN インタフェースでのパケットフィルタリングの適用範囲の設定

パケットフィルタリングのために VLAN インタフェースに ACL を適用するには、以下のいずれかのコマンドを使用できます。

- **match ip address** { *acl-name* | *acl-number* }
- **match ipv6 address** { *acl-name* | *acl-number* }
- **match mac address** { *acl-name* | *acl-number* }

1.9. ACLの表示と維持

すべての view で **display** コマンドを実行でき、user view で **reset** コマンドを実行できます。

操作	コマンド
ACL設定情報を表示する	**display acl** [**ip** [*name* | *number*] | **mac** [*name* | *number*] | **ipv6** [*name* | *number*] | **expert** [*name* | *number*] | **arp** [*name*]]
インタフェースのアクセスグループ情報を表示する	**display access-group** [**interface** *interface-list*]
VLANアクセスマップ設定情報を表示する	**display vlan access-map** [*map-name*]
VLANインタフェース上のVLANフィルタ設定を表示する	**display vlan filter** [**access-map** *map-name* | **vlan** *vlan-id*]
ACLハードウェアカウンタを削除する	**reset acl-hardware-counter** { **access-group** [*access-list-name* | *access-list-number*] | **vlan-filter** [*access-map-name*] }

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

6. セキュリティ

本マニュアルは以下に示す章で構成されています。

01-AAA

02-SSH

目次

このセクションのページは **6-x-x** です。

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1章 AAA

> 🕮 メモ：
> RADIUS 機能は現在のソフトウェアではサポートしていません。

1.1. 概要

1.1.1. AAA

認証、許可、およびアカウンティング（AAA）は、ネットワークアクセス管理を実装するための統一されたフレームワークを提供します。この機能は、以下のセキュリティ機能を規定します。

- **認証** – ユーザを識別し、その有効性を検証します。
- **許可（認可）** – 異なるユーザに異なる権限を付与し、リソースやサービスへのアクセスを制御します。例えば、社内ユーザにはファイルの閲覧と印刷を許可し、ゲストユーザが装置上のファイルにアクセスできないように制限できます。
- **アカウンティング** – サービスのタイプ、開始時刻、トラフィック量など、ユーザのネットワーク使用状況を詳細に記録します。この機能により、時間ベースおよびトラフィックベースの課金、ならびにユーザ行動の監査が可能になります。

AAA はクライアント/サーバモデルを採用しています。クライアントはアクセス装置、またはネットワークアクセスサーバ（NAS）上で動作し、ユーザ ID を認証しユーザアクセスを制御します。サーバはユーザ情報を一元的に管理します。図 1-1 を参照してください。

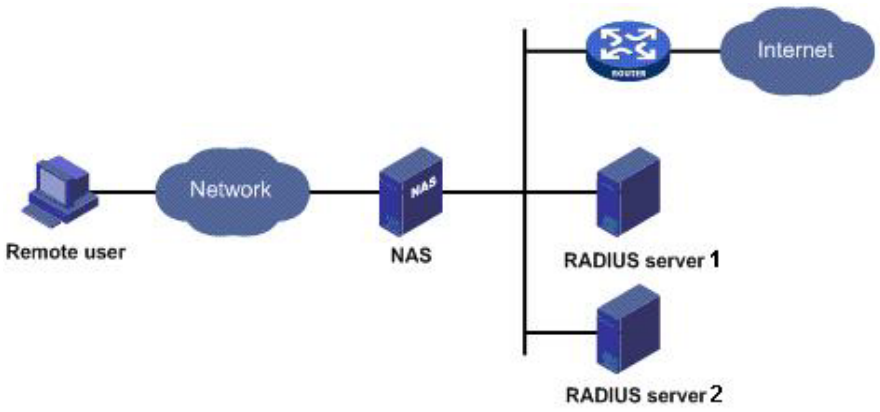


図 1-1 AAA ネットワーク図

NAS の外部にあるネットワークやリソースにアクセスするには、ユーザは自身の識別情報を NAS に送信します。NAS はユーザ情報を AAA サーバに透過的に転送し、認証、許可、およびアカウンティングの結果を待ちます。その結果に基づき、NAS はアクセス要求を許可するか拒否するかを決定します。

AAA には様々な実装があり、その中でも RADIUS が最も頻繁に使用されます。

図 1-1 のネットワークには、RADIUS サーバ 1 と RADIUS サーバ 2 が 1 台ずつ存在します。異なるサーバを使用して、異なるセキュリティ機能を実装できます。例えば、認証と許可には RADIUS サーバ 1 を使用し、アカウンティングには RADIUS サーバ 2 を使用できます。

AAA が提供するセキュリティ機能は必要に応じて選択できます。例えば、特定のリソースにアクセスする前に従業員を認証させたい場合、認証サーバを導入します。ネットワーク使用状況情報が必要な場合は、アカウンティングサーバも設定します。

本装置はダイナミックパスワード認証を実行します。

1.1.1. RADIUS

リモート認証ダイヤルインユーザサービス（RADIUS）は、クライアント／サーバモデルを採用した分散型情報相互作用プロトコルです。このプロトコルはネットワークを不正アクセスから保護でき、高いセキュリティとリモートユーザアクセスを同時に必要とするネットワーク環境で頻繁に利用されます。

RADIUS 認証プロセスは RADIUS 許可プロセスと統合されており、ユーザ許可情報は認証応答に付随して伝送されます。RADIUS は認証に UDP ポート 1812、アカウンティングに UDP ポート 1813 を使用します。

RADIUS は当初ダイヤルインユーザアクセス向けに設計されましたが、Ethernet や ADSL などの追加アクセス方式をサポートするよう拡張されています。

I. クライアント/サーバモデル

RADIUS クライアントはネットワーク全体に配置された NAS 上で動作します。ユーザ情報を RADIUS サーバに送信し、応答に基づいてユーザアクセス要求を拒否または許可するなどの処理を行います。

RADIUS サーバはネットワークセンターのコンピュータまたはワークステーション上で動作し、ユーザ認証およびネットワークサービスアクセスに関連する情報を管理します。

RADIUS サーバは以下のプロセスで動作します。

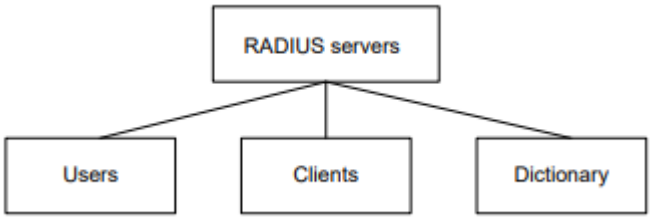
1. RADIUS クライアントから認証、許可、およびアカウンティング要求を受信します。
2. ユーザ認証、許可、またはアカウンティングを実行します。
3. クライアントに対してユーザアクセス制御情報（例：ユーザアクセス要求の拒否または承認）を返します。

RADIUS サーバは、別の RADIUS サーバのクライアントとして動作し、認証プロキシサービスを提供することもできます。

RADIUS サーバは以下のデータベースを維持します。

- **Users** – ユーザ名、パスワード、適用プロトコル、IP アドレスなどのユーザ情報を格納します。
- **Clients** – 共有鍵や IP アドレスなど、RADIUS クライアントに関する情報を格納します。
- **Dictionary** – RADIUS プロトコル属性とその値を格納します。

II. RADIUS サーバデータベース



III. 情報交換セキュリティメカニズム

RADIUS クライアントとサーバは、クライアントとサーバに事前設定された共有鍵を用いて相互に情報を交換します。RADIUS パケットには「Authenticator」と呼ばれる 16 バイトのフィールドがあります。このフィールドには、MD5 アルゴリズム、共有鍵、およびその他の情報を使用して生成された署名が含まれます。パケットの受信側は署名を検証し、署名が正しい場合にのみパケットを受け入れます。このメカニズムにより、RADIUS クライアントとサーバ間で交換される情報の安全性が確保されます。

共有鍵は、RADIUS パケットに含まれるユーザパスワードの暗号化にも使用されます。

IV. ユーザ認証方式

RADIUS サーバは、PAP、CHAP、EAP など複数のユーザ認証方式をサポートしています。

V. 基本的な RADIUS パケット交換プロセス

図 1-2 は、ユーザホスト、RADIUS クライアント、および RADIUS サーバ間の相互作用を示しています。

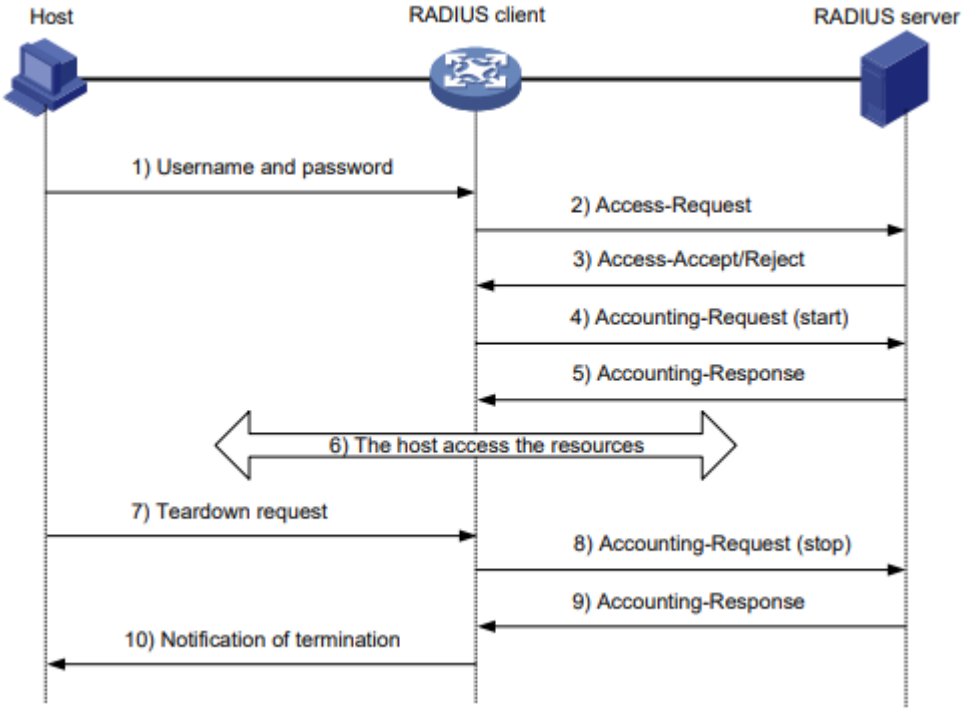


図 1-2 基本的な RADIUS パケット交換プロセス

RADIUS は以下のように動作します。

1. ホストは、RADIUS クライアントにユーザ名とパスワードを転送し、接続リクエストを送信し始めます。
2. ユーザ名とパスワードを受信した後、RADIUS クライアントは MD5(Message-Digest5)アルゴリズムを使用して暗号化されたユーザパスワードと共有鍵をもつ認証要求(Access-Request)パケットを RADIUS サーバに送信します。
3. RADIUS サーバはユーザ名とパスワードを認証します。認証が成功した場合、ユーザの許可情報を含む Access-Accept message パケットを送り返します。認証に失敗した場合、Access-Reject message パケットを送り返します。
4. RADIUS クライアントは、返された認証結果に従ってユーザを許可、または拒否します。ユーザを許可した場合、クライアントは RADIUS サーバにアカウンティング開始要求(Accounting-Request)パケットを送信します。
5. RADIUS サーバはアカウンティング開始応答(Accounting-Response)パケットを返し、アカウンティングし始めます。
6. ユーザはネットワークリソースにアクセスすることができるようになります。
7. ホストが RADIUS クライアントに接続切断要求を行います。
8. RADIUS クライアントは RADIUS サーバにアカウンティング停止要求(Accounting-Request)パケットを送信します
9. RADIUS サーバは、ユーザのアカウンティングを停止するためにアカウンティング停止応答(Accounting-Response)パケットをクライアントに送り返します。
10. ユーザのネットワークリソースへのアクセスが停止します。

VI. RADIUS パケット形式

RADIUS はパケットの送信に UDP を使用します。このプロトコルは RADIUS サーバとクライアント間の円滑なパケット交換を確保するための一連のメカニズムを採用しています。これらのメカニズムには、タイマメカニズム、再送信メカニズム、およびバックアップサーバメカニズムが含まれます。

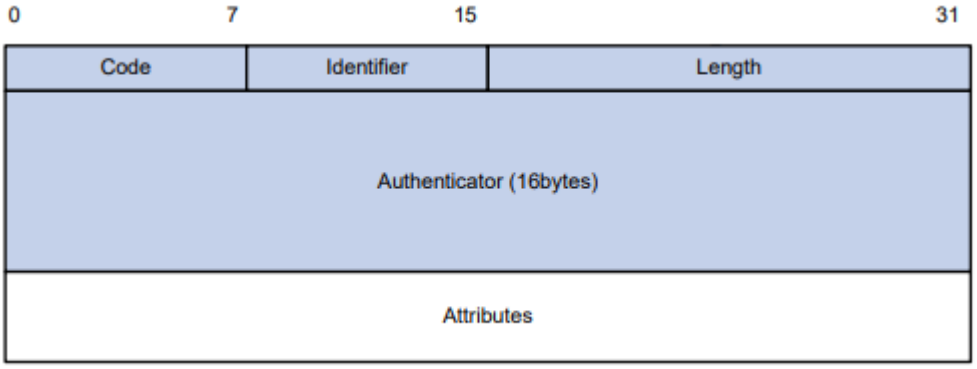


図 1-3 RADIUS パケット形式

各フィールドの説明は以下の通りです。

- Code フィールド（1 バイト長）は、RADIUS パケットのタイプを示します。主な値とその意味は表 1-1 に示されています。

表 1-1 コードフィールドの主な値

コード	パケットタイプ	説明
1	Access-Request	クライアントからサーバへ送信されます。このタイプのパケットには、サーバがユーザを認証するためのユーザ情報が含まれます。User-Name属性を必ず含み、NAS-IP-Address、User-Password、NAS-Port属性を任意で含めることができます。
2	Access-Accept	サーバからクライアントへ送信されます。Access-Requestに含まれる全属性値が許容可能であれば、認証は成功し、サーバはAccess-Accept応答を送信します。
3	Access-Reject	サーバからクライアントへ送信されます。Access-Requestに含まれる属性値のいずれかが受け入れられない場合、認証は失敗し、サーバはAccess-Reject応答を送信します。
4	Accounting-Request	クライアントからサーバへ送信されます。このタイプのパケットには、サーバがユーザのアカウンティングを開始または停止するためのユーザ情報が含まれます。パケット内のAcct-Status-Type属性は、アカウンティングを開始するか停止するかを示します。
5	Accounting-Response	サーバからクライアントへ送信されます。サーバは、Accounting-Requestを受信し、アカウンティング情報を正常に記録したことをクライアントに通知するためにこのタイプのパケットを送信します。

- Idenfier フィールド（1 バイト長）は、応答パケットと要求パケットを照合し、重複した要求パケットを検出するために使用されます。同じ交換プロセスにおける同じ目的（認証やアカウンティングなど）の要求パケットと応答パケットは、同じ識別子を持ちます。
- Length フィールド（2 バイト長）は、コード、識別子、長さ、認証子、属性フィールドを含むパケット全体の長さ（バイト単位）を示します。この長さを超えるバイトはパディングと見なされ、受信側で無視されます。受信したパケットの長さがこの長さに満たない場合、パケットは破棄されます。
- Authenticator フィールド（16 バイト長）は、RADIUS サーバからの応答を認証し、ユーザパスワードを暗号化するために使用されます。認証子には、要求認証子と応答認証子の 2 種類があります。
- Attributes フィールド（可変長）には、認証、許可、およびアカウンティング情報が含まれます。このフィールドには複数の属性が含まれる可能性があり、各属性は次のサブフィールドを持ちます。
  - **Type** – 属性のタイプ
  - **Length** – 属性全体のバイト数（タイプ、長さ、値の各サブフィールドを含む）
  - **Value** – 属性の値。その形式と内容は Type サブフィールドに依存します。

  一般的に使用される RADIUS 属性は RFC 2865、RFC 2866、RFC 2867、および RFC 2868 で定義されています。

表 1-2 よく使用される RADIUS 属性

番号	属性	番号	属性
1	User-Name	45	Acct-Authentic
2	User-Password	46	Acct-Session-Time

番号	属性	番号	属性
3	CHAP-Password	47	Acct-Input-Packets
4	NAS-IP-Address	48	Acct-Output-Packets
5	NAS-Port	49	Acct-Terminate-Cause
6	Service-Type	50	Acct-Multi-Session-Id
7	Framed-Protocol	51	Acct-Link-Count
8	Framed-IP-Address	52	Acct-Input-Gigawords
9	Framed-IP-Netmask	53	Acct-Output-Gigawords
10	Framed-Routing	54	(unassigned)
11	Filter-ID	55	Event-Timestamp
12	Framed-MTU	56-59	(unassigned)
13	Framed-Compression	60	CHAP-Challenge
14	Login-IP-Host	61	NAS-Port-Type
15	Login-Service	62	Port-Limit
16	Login-TCP-Port	63	Login-LAT-Port
17	(unassigned)	64	Tunnel-Type
18	Reply-Message	65	Tunnel-Medium-Type
19	Callback-Number	66	Tunnel-Client-Endpoint
20	Callback-ID	67	Tunnel-Server-Endpoint
21	(unassigned)	68	Acct-Tunnel-Connection
22	Framed-Route	69	Tunnel-Password
23	Framed-IPX-Network	70	ARAP-Password
24	State	71	ARAP-Features
25	Class	72	ARAP-Zone-Access
26	Vendor-Specific	73	ARAP-Security
27	Session-Timeout	74	ARAP-Security-Data
28	Idle-Timeout	75	Password-Retry
29	Termination-Action	76	Prompt
30	Called-Station-Id	77	Connect-Info
31	Calling-Station-Id	78	Configuration-Token
32	NAS-Identifier	79	EAP-Message
33	Proxy-State	80	Message-Authenticator
34	Login-LAT-Service	81	Tunnel-Private-Group-ID
35	Login-LAT-Node	82	Tunnel-Assignment-id
36	Login-LAT-Group	83	Tunnel-Preference
37	Framed-AppleTalk-Link	84	ARAP-Challenge-Response
38	Framed-AppleTalk-Network	85	Acct-Interim-Interval
39	Framed-AppleTalk-Zone	86	Acct-Tunnel-Packets-Lost
40	Acct-Status-Type	87	NAS-Port-Id

番号	属性	番号	属性
41	Acct-Delay-Time	88	Framed-Pool
42	Acct-Input-Octets	89	(unassigned)
43	Acct-Output-Octets	90	Tunnel-Client-Auth-id
44	Acct-Session-Id	91	Tunnel-Server-Auth-id

VII. 拡張 RADIUS 属性

RADIUS プロトコルは優れた拡張性を備えています。ベンダ固有属性（属性 26）により、ベンダは拡張属性を定義できます。拡張属性は、標準 RADIUS プロトコルが提供しない機能を実装できます。

ベンダは、拡張機能を提供するために、属性 26 内で複数のサブ属性を TLV 形式でカプセル化できます。図 1-4 に示すように、属性 26 にカプセル化されたサブ属性は以下の部分で構成されます。

- **Vendor-ID** – ベンダ ID です。最上位バイトは 0 です。残りの 3 バイトは RFC 1700 に準拠したコードを含みます。
- **Vendor-Type** – サブ属性のタイプです。
- **Vendor-Length** – サブ属性の長さです。
- **Vendor-Data** – サブ属性の内容です。

本装置は、31874（アルファ）の RADIUS サブ属性をサポートします。

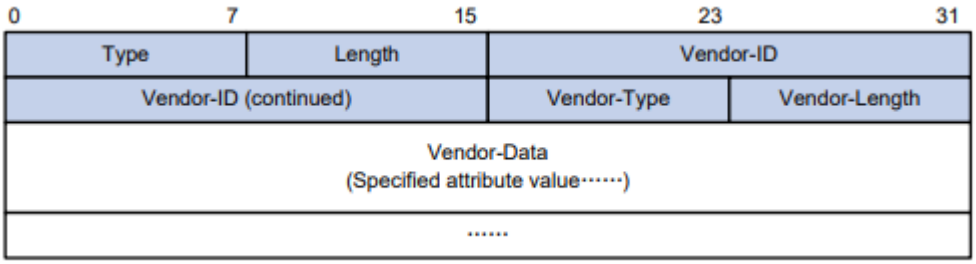


図 1-4 属性 26 の形式

1.1.2. ISP ドメインにもとづくユーザ管理

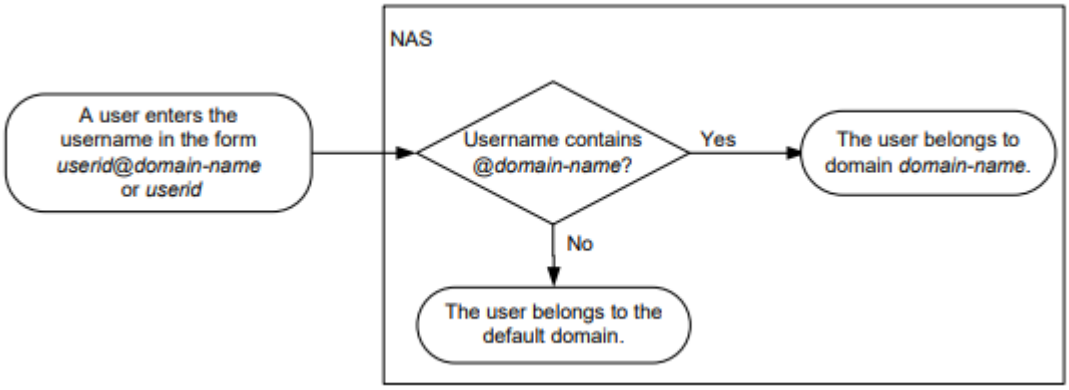
このセクションでは、AAA ユーザ管理とその方法について説明します。

I. ISP ドメインとユーザアクセスタイプに基づくユーザ管理

AAA は、ユーザの ISP ドメインとアクセスタイプに基づいてユーザを管理します。

NAS では、各ユーザは 1 つの ISP ドメインに所属します。NAS は、ユーザがログイン時に入力したユーザ名に基づいて、そのユーザが所属する ISP ドメインを決定します。

II. ユーザ名による ISP ドメインの判定



AAA は、ユーザのアクセスタイプに基づいて、同一 ISP ドメイン内のユーザを管理します。本装置は、以下のユーザアクセスタイプをサポートします。

- **LAN** – LAN ユーザオンラインになるために 802.1X または MAC 認証を通過する必要があります。
- **Login** – ログインユーザには、装置にログインする SSH、Telnet、FTP、およびターミナルユーザが含まれます。ターミナルユーザはコンソールポート経由でアクセスできます。
- **HTTP または HTTPS** – ユーザは HTTP または HTTPS 経由で装置にログインします。

1.1.3. 認証方式、許可方式、アカウンティング方式

AAA は、ISP ドメイン内の異なるタイプのユーザに対して、異なる認証、許可、およびアカウンティング方式を設定することをサポートします。NAS は、ユーザの ISP ドメインとアクセスタイプを決定します。NAS はまた、ドメイン内でアクセスタイプに対して設定された方式を使用して、ユーザのアクセスを制御します。

AAA は、ISP ドメインに対するデフォルト方式のセット設定もサポートします。これらのデフォルト方式は、AAA 方式が設定されていないユーザに適用されます。

I. 認証方式

本装置がサポートする認証方式は以下の通りです。

- **認証なし** – この方式ではすべてのユーザを信頼し、認証を実行しません。セキュリティ上の理由から、この方式を使用しないでください。
- **ローカル認証** – NAS がローカルに設定されたユーザ情報（ユーザ名、パスワード、属性など）に基づいてユーザを認証します。ローカル認証は高速かつ低コストですが、保存可能な情報量はストレージ容量によって制限されます。
- **リモート認証** – NAS は RADIUS サーバと連携してユーザ認証を行います。サーバはユーザ情報を集中管理します。リモート認証は、複数の NAS に対して大容量で信頼性の高い集中認証サービスを提供します。リモートサーバが利用できない場合に使用するバックアップ方式を設定できます。

II. 許可方式

本装置は以下の許可方式をサポートします。

- **認証なし** – NAS は認証交換を一切行いません。ユーザが認証を通過した後は、以下のデフォルト認証情報が適用されます。
  - 非ログインユーザはネットワークにアクセスできます。
  - ログインユーザはレベル 0 のユーザロールを取得します。
  - FTP、SFTP ログインユーザの作業ディレクトリは NAS のルートディレクトリです。ただし、ユーザはルートディレクトリへのアクセス権限を持ちません。
- **ローカル認証** – NAS はユーザに対してローカルに設定されたユーザ属性に基づいて認証を行います。
- **リモート認証** – NAS は RADIUS サーバと連携してユーザを認証します。RADIUS 認証は RADIUS 許可と連動しています。RADIUS 許可は RADIUS 認証が成功した後にのみ機能し、許可情報は Access-Accept パケットに含まれます。リモートサーバが利用できない場合に使用するバックアップ方式を設定できます。

III. アカウンティング方式

本装置は以下のアカウンティング方式をサポートします。

- **アカウンティングなし** – NAS はユーザに対するアカウンティングを実行しません。
- **ローカルアカウンティング** – ローカルアカウンティングは NAS 上で実装されます。同一のローカルユーザアカウントを使用する同時接続ユーザ数をカウントおよび制御しますが、課金用の統計情報は提供しません。
- **リモートアカウンティング** – NAS はアカウンティングのために RADIUS サーバと連携します。リモートサーバが利用できない場合に使用するバックアップ方式を設定できます。

1.1.4. プロトコルと標準

- RFC 2865, *Remote Authentication Dial In User Service (RADIUS)*
- RFC 2866, *RADIUS Accounting*
- RFC 2867, *RADIUS Accounting Modifications for Tunnel Protocol Support*
- RFC 2868, *RADIUS Attributes for Tunnel Protocol Support*
- RFC 2869, *RADIUS Extensions*

1.1.5. RADIUS 属性

I. 一般的に使用される標準 RADIUS 属性

番号	属性	説明
1	User-Name	認証対象のユーザ名です。
2	User-Password	PAP認証のユーザパスワードです。PAPが使用される場合にのみ、Access-Requestパケットに含まれます。
3	CHAP-Password	CHAP認証のユーザパスワードのダイジェストです。CHAP認証が使用される場合にのみ、Access-Requestパケットに存在します。
4	NAS-IP-Address	クライアントを識別するためにサーバが使用するIPアドレスです。通常、クライアントはアクセスインタフェースのIPアドレスで識別されます。この属性はAccess-Requestパケットにのみ存在します。

番号	属性	説明
5	NAS-Port	ユーザがアクセスするNASの物理ポートです。
6	Service-Type	ユーザが要求したサービスのタイプ、または提供されるサービスのタイプです。
7	Framed-Protocol	フレームアクセス用のカプセル化プロトコルです。
8	Framed-IP-Address	ユーザに割り当てられるIPアドレスです。
11	Filter-ID	フィルタリスト名です。
12	Framed-MTU	ユーザとNAS間のデータリンクにおけるMTUです。例えば、この属性は802.1X EAP認証において処理が許可されるEAPパケットの最大サイズを定義するために使用できます。
14	Login-IP-Host	ユーザがアクセスするNASインタフェースのIPアドレスです。
15	Login-Service	ユーザがログインに使用するサービスのタイプです。
18	Reply-Message	ユーザに表示されるテキストです。サーバが認証失敗の理由などの情報を伝達するために使用できます。
26	Vendor-Specific	ベンダ固有の独自属性です。パケットは1つ以上の独自属性を含み、各属性は1つ以上のサブ属性を含むことができます。
27	Session-Timeout	セッション終了前のユーザに対する最大サービス継続時間です。
28	Idle-Timeout	セッション終了前にユーザに許可される最大アイドル時間です。
31	Calling-Station-Id	NASがサーバに送信するユーザ識別情報です。NEC装置が提供するLANアクセスサービスでは、この属性にはユーザのMACアドレスがHHHH-HHHH-HHHH形式で含まれます。
32	NAS-Identifier	NASがRADIUSサーバに対して自身を識別するために使用する識別子です。
40	Acct-Status-Type	Accounting-Requestパケットタイプです。可能な値は以下の通りです。 • **1** – 開始 • **2** – 停止 • **3** – 中間更新 • **4** – 課金リセット • **7** – アカウンティングオン(第 3 世代パートナーシッププロジェクトで定義) • **8** – アカウンティングオフ(第 3 世代パートナーシッププロジェクトで定義) • **9～14–**トンネルアカウンティング用に予約済み • **15** – 失敗用に予約済み

番号	属性	説明
45	Acct-Authentic	ユーザによって使われる認証方式です。可能な値は以下の通りです。 • **1** – RADIUS • **2** – ローカル • **3** – リモート
60	CHAP-Challenge	CHAP認証中のMD5計算のためにNASによって生成されるCHAPチャレンジです。
61	NAS-Port-Type	ユーザを認証するNASの物理ポートのタイプです。可能な値は以下の通りです。 • **15** – Ethernet • **16** – あらゆるタイプの ADSL • **17** – ケーブル (ケーブルテレビ用のケーブル付き) • **19** – WLAN-IEEE 802.11 • **201** – VLAN • **202** – ATM ポートがATMやEthernetであり、VLANが実装されている場合、この属性の値は201です。
64	Tunnel-Type	使用されるトンネリングプロトコルです。値13はVLANを表します。
65	Tunnel-Medium-Type	トンネル作成に使用する伝送媒体タイプです。 VLAN割り当ての場合、802メディアとEthernetを示すには値を**6** にする必要があります。
79	EAP-Message	EAPパケットをカプセル化して、RADIUSがEAP認証をサポートできるようにするために使用されます。
80	Message-Authenticator	認証パケットの認証および検証に使用され、Access-Requestのなりすましを防止します。この属性はEAP認証が使用される場合に存在します。
81	Tunnel-Private-Group-ID	トンネルセッションのグループIDです。VLANを割り当てる際、NASはこの属性を使用してVLAN IDを伝達します。
87	NAS-Port-Id	ユーザを認証するNASのポートを記述する文字列です。
168	Framed-IPv6-Address	NASがホストに割り当てるサーバ割り当てIPv6アドレスです。アドレスは一意である必要があります。

1.2. RADIUSのトラブルシューティング

1.2.1. RADIUS 認証の失敗

I. 症状

ユーザ認証が常に失敗します。

II. 分析

考えられる原因：

- NAS と RADIUS サーバ間の通信障害が発生しています。
- ユーザ名が *userid@isp-name* 形式でない、または NAS 上で ISP ドメインが正しく設定されていません。
- RADIUS サーバにユーザが設定されていません。
- ユーザが入力したパスワードが正しくありません。
- RADIUS サーバと NAS は異なる共有鍵で設定されています。

III. 解決策

問題を解決するには：

1. 以下の項目を確認してください。
    - NAS と RADIUS サーバが相互に ping を送信できることを確認してください。
    - ユーザ名は *userid@isp-name* 形式であり、NAS 上で ISP ドメインが正しく設定されていることを確認してください。
    - ユーザが RADIUS サーバに設定されていることを確認してください。
    - 正しいパスワードが入力されていることを確認してください。
    - RADIUS サーバと NAS の両方で同じ共有鍵が設定されていることを確認してください。
2. 問題が解決しない場合、販売店もしくは担当営業に問い合わせてください。

1.2.2. RADIUS パケット配信失敗

I. 症状

RADIUS パケットが RADIUS サーバに到達できません。

II. 分析

考えられる原因：

- NAS と RADIUS サーバ間の通信障害が発生しています。
- NAS に RADIUS サーバの IP アドレスが設定されていません。
- NAS に設定されている認証およびアカウンティング用 UDP ポートが正しくありません。
- RADIUS サーバの認証およびアカウンティングポート番号が他のアプリケーションで使用されています。

III. 解決策

問題を解決するには：

1. 以下の項目を確認してください。
    - NAS と RADIUS サーバ間のリンクが、物理層およびデータリンク層の両方で正常に機能していることを確認してください。
    - NAS 上で RADIUS サーバの IP アドレスが正しく設定されていることを確認してください。
    - NAS に設定されている認証およびアカウンティング用 UDP ポート番号が、RADIUS サーバのものと一致していることを確認してください。
    - RADIUS サーバの認証およびアカウンティングポート番号が利用可能であることを確認してください。
2. 問題が解決しない場合、販売店もしくは担当営業に問い合わせてください。

1.2.3. RADIUS アカウンティングエラー

I. 症状

ユーザは認証および許可されていますが、そのユーザのアカウンティングは正常ではありません。

II. 分析

NAS 上のアカウンティングサーバ設定が正しくありません。考えられる原因は以下の通りです。

- NAS に設定されたアカウンティングポート番号が誤っています。
- NAS に設定されたアカウンティングサーバの IP アドレスが誤っています。例えば、NAS が認証・許可・アカウンティングサービスを単一サーバで提供するように設定されているが、実際には異なるサーバが各サービスを提供しています。

III. 解決策

問題を解決するには：

1. 以下の項目を確認してください。
    - アカウンティングポート番号が正しく設定されていることを確認してください。
    - アカウンティングサーバの IP アドレスは NAS に正しく設定されていることを確認してください。
2. 問題が解決しない場合、販売店もしくは担当営業に問い合わせてください。

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2章 SSH

2.1. 概要

Secure Shell (SSH)は、ネットワークセキュリティプロトコルです。暗号化と認証を使用することで、SSH は安全でないネットワーク上で安全なリモートアクセスとファイル転送を実現します。

SSH は、典型的なクライアント・サーバモデルを使用して、TCP ベースの安全なデータ転送チャネルを確立します。

本装置は以下の SSH アプリケーションをサポートします。

- **SSH**－SSH は安全で信頼性の高いネットワーク端末アクセスサービスを提供します。SSH を通じて、ユーザはリモートサーバに安全にログインできます。SSH は IP スプーフィングや平文パスワードの傍受などの攻撃から装置を保護します。装置は SSH サーバまたは SSH クライアントとして動作できます。
- **SFTP（Secure File Transfer Protocol）**–SSH2 をもとにして SSH を使用した SFTP は安全なファイル転送を提供します。装置は SFTP サーバとして動作し、リモートユーザが安全なファイル管理と転送を行うため、SFTP サーバにログインできます。また装置は SFTP クライアントとして動作します。ユーザが装置からリモート装置にログインし、安全なファイル転送を行うことができます。

SSH クライアントまたはサーバとして動作する場合、装置は以下の SSH バージョンをサポートします。

- SSH クライアントとして動作する場合、装置は SSH2 のみをサポートします。
- SSH または SFTP として動作する場合、本装置は SSH2 をサポートします。

2.1.1. SSH の動作

このセクションでは、SSH セッションを確立する段階について、SSH2 を例に説明します。

表 2-1 SSH セッションを確立する段階

段階	説明
接続確立	SSHサーバはポート22で接続要求を待機します。クライアントが接続要求を開始すると、サーバとクライアントはTCP接続を確立します。
バージョンネゴシエーション	SSHバージョン2が使用されます。
アルゴリズムネゴシエーション	SSHは複数のアルゴリズムをサポートします。ローカルアルゴリズムに基づき、両者は以下のアルゴリズムをネゴシエーションします。 • セッション鍵を生成するための鍵交換アルゴリズム • データを暗号化するための暗号化アルゴリズム • デジタル署名および認証のための公開鍵アルゴリズム • データ完全性を保護するための HMAC アルゴリズム
鍵交換	両者はDH交換アルゴリズムを用いてセッションキーとセ

段階	説明
	ッションIDをダイナミックに生成します。 • セッション鍵はデータ転送の保護に使用されます。 • セッション ID は SSH 接続の識別に使用されます。 この段階で、クライアントはサーバの認証も行います。
認証	SSHサーバは、クライアントの認証要求に応答してクライアントを認証します。
セッション要求	認証を通過した後、クライアントはセッションの確立を要求するためにサーバにセッション要求を送信します。
相互作用	サーバがリクエストを承認すると、クライアントとサーバはセッション内で相互通信を開始します。 この段階では、テキスト形式でコマンドを貼り付けてCLIで実行できます。一度に貼り付けるテキストは2000バイト以内である必要があります。コマンドの正しい実行を確保するためのベストプラクティスとして、同じview内のコマンドを貼り付けることを推奨します。 2000バイトを超えるコマンドを実行するには、コマンドをコンフィグレーションファイルに保存し、SFTP 経由でサーバにアップロードし、サーバの再起動に使用してください。

2.1.2. SSH 認証方式

このセクションでは、装置が SSH サーバとして動作する際にサポートされる認証方式について説明します。

I. パスワード認証

SSH サーバは AAA メカニズムを通じてクライアントを認証します。パスワード認証のプロセスは以下の通りです。

1. クライアントは、暗号化されたユーザ名とパスワードを含む認証要求をサーバに送信します。
2. サーバは以下の操作を実行します。
    a. 要求を復号化し、平文のユーザ名とパスワードを取得します。
    b. ユーザ名とパスワードをローカルまたはリモート AAA 認証を通じて検証します。
    c. 認証結果をクライアントに通知します。

リモート AAA サーバが二次認証用にパスワード入力を要求する場合、プロンプトを含む認証応答を SSH サーバに送信します。プロンプトはクライアントに透過的に転送され、ユーザに特定のパスワード入力が通知されます。ユーザが正しいパスワードを入力すると、AAA サーバはパスワードの有効性を検証します。パスワードが有効な場合、SSH サーバは認証成功メッセージをクライアントに返します。

II. 公開鍵認証

サーバはクライアントのデジタル署名を検証することでクライアントを認証します。公開鍵認証のプロセスは以下の通りです。

1. クライアントは、ユーザ名、公開鍵、公開鍵アルゴリズム名を含む公開鍵認証要求をサーバに送信します。

2. 認証においてクライアントのデジタル証明書が必要な場合、クライアントは認証要求にデジタル証明書をカプセル化します。デジタル証明書にはクライアントの公開鍵情報が含まれます。
3. サーバはクライアントの公開鍵を検証します。
   - 公開鍵が無効な場合、サーバは認証失敗をクライアントに通知します。
   - 公開鍵が有効な場合、サーバはクライアントのデジタル署名を要求します。署名を受信後、サーバは公開鍵を使用して署名を検証し、認証結果をクライアントに通知します。

SSH サーバとして動作する場合、装置は公開鍵アルゴリズム DSA および RSA を使用したデジタル署名の検証をサポートします。

SSH クライアントとして動作する場合、本装置は公開鍵アルゴリズム DSA および RSA を使用したデジタル署名生成をサポートします。

2.2. SSHサーバの設定

2.2.1. SSH サーバ設定作業リスト

作業リスト	補足
(必須設定項目) ローカル鍵ペアの作成	―
(必須設定項目) SSHサーバの有効化	SSHサーバのみ必須設定項目です。
(必須設定項目) SSHログインのユーザラインの設定	SSHサーバのみ必須設定項目です。
(必須設定項目) クライアントのホスト公開鍵の設定	認証方法が**publickey**または**password**の場合、必須設定項目です。
(必須設定項目/オプション設定項目) SSHユーザの設定	認証方式が**publickey**または**password**の場合、必須設定項目です。 認証方式が**password**の場合、オプション設定項目です。
(オプション設定項目) SSH管理パラメータの設定	―

2.2.2. ローカル鍵ペアの作成

SSH サーバ上の DSA または RSA 鍵ペアは、鍵交換段階におけるセッション鍵とセッション ID の作成に必要です。これらはクライアントがサーバを認証する際にも使用されます。クライアントがサーバを認証する際には、サーバから受信した公開鍵と、クライアントがローカルに保存したサーバの公開鍵を比較します。鍵が一致する場合、クライアントはローカルに保存されたサーバの公開鍵を使用して、サーバから受信したデジタル署名を復号します。復号に成功した場合、サーバ認証を通過します。

SSH アプリケーションは、装置上で SSH サーバコマンドを実行すると起動します。装置にデフォルト名の RSA 鍵ペアが存在しない場合、装置は自動的に RSA サーバ鍵ペア 1 組と RSA ホスト鍵ペア 1 組を作成します。両方の鍵ペアはデフォルト名を使用します。また、**crypto key generate** コマンドを使用して、装置上で DSA または RSA 鍵ペアを作成することもできます。

I. 制限事項とガイドライン

ローカル鍵ペアを作成する際は、以下の制限事項とガイドラインに従ってください：

- **crypto key generate rsa** コマンドは、RSA 用のサーバ鍵ペアとホスト鍵ペアを作成します。
- **crypto key generate dsa** コマンドは、DSA ホスト鍵ペアのみを作成します。SSH サーバ上で DSA 鍵ペアを作成する場合、鍵のモジュラス長は 2048 ビット未満である必要があります。

II. 設定手順

SSH サーバ上でローカル鍵ペアを作成するには：

操作	コマンド	補足
1. ローカル鍵ペアを作成する	**crypto key generate** { **rsa** [**modulus** *modulus-size*] | **dsa** }	デフォルト：サーバにローカル鍵ペアは存在しません。

2.2.3. SSH サーバの有効化

装置で SSH サーバを有効にすると、クライアントは SSH 経由で装置にログインできます。

SSH サーバを有効にするには:

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. SSH サーバを有効にする	**ssh server enable**	デフォルト：無効

2.2.4. SSH ログインのユーザラインの設定

SSH アプリケーションによっては、SSH クライアントは SSH クライアントまたは SFTP クライアントとして動作します。ユーザラインの設定は、クライアントの次回ログイン時に有効になります。

SSH クライアントのユーザラインを設定するには：

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. VTY user line view に移行する	**line vty** *number* [*ending-number*]	—
3. ログイン認証モードを scheme に設定する	**authentication-mode scheme**	デフォルト：認証モードは **password**です。

2.2.5. クライアントのホスト公開鍵の設定

公開鍵認証では、サーバはクライアントから受信した SSH ユーザ名とクライアントのホスト公開鍵を、ローカルに保存されている SSH ユーザ名とクライアントのホスト公開鍵と比較します。これらが一致する場合、サーバはクライアントが送信するデジタル署名を検証します。クライアントは、自身のホスト公開鍵とペアになっている秘密鍵を使用してデジタル署名を生成します。

公開鍵認証では、以下の作業を実行する必要があります。

1. サーバ上でクライアントの DSA または RSA ホスト公開鍵を設定します。

2. クライアント上でデジタル署名を生成するために、関連するホスト秘密鍵を指定します。

   装置が SSH クライアントとして動作する場合、クライアント上で公開鍵アルゴリズムを指定します。このアルゴリズムによって、デジタル署名生成に利用されるホスト秘密鍵が決定されます。

クライアントのホスト公開鍵の内容を入力するか、公開鍵ファイルからクライアントのホスト公開鍵をインポートできます。ベストプラクティスとして、クライアントのホスト公開鍵をインポートしてください。

II. クライアントのホスト公開鍵の入力

クライアントのホスト公開鍵を入力するには：

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. クライアントのホスト公開鍵を設定する	クライアントのホスト公開鍵の内容を入力する	ホスト公開鍵は、変換せずに DER エンコーディング形式である必要があります。 クライアントのホスト公開鍵の内容を入力する際、文字間にスペースや改行を使用できます。ホスト公開鍵を保存すると、スペースや改行は自動的に削除されます。

III. クライアントのホスト公開鍵を公開鍵ファイルからインポート

ホスト公開鍵をインポートする前に、クライアントの公開鍵ファイル（バイナリ形式）をサーバにアップロードしてください。（例：FTP または TFTP 経由）インポート処理中に、サーバは公開鍵ファイル内のホスト公開鍵を自動的に PKCS 形式の文字列に変換します。

2.2.6. SSH ユーザの設定

認証方式に応じて、SSH ユーザとローカルユーザを設定します。

- 認証方式が **publickey** の場合、SSH サーバ上に SSH ユーザとローカルユーザを作成する必要があります。両ユーザは同一のユーザ名を持つ必要があり、これにより SSH ユーザに正しい作業ディレクトリとユーザロールを割り当てられます。
- 認証方式が **password**,の場合、以下のいずれかの操作を実行する必要があります。
  - ローカル認証の場合、SSH サーバ上でローカルユーザを設定します。
  - リモート認証の場合、リモート認証サーバ（例：RADIUS サーバ）に SSH ユーザを設定します。

  SSH ユーザを **ssh user** コマンドで作成する必要はありません。ただし、パスワードのみの SSH ユーザを含むすべての SSH ユーザを集中管理のために表示したい場合は、このコマンドを使用して作成できます。そのような SSH ユーザを作成した場合は、正しいサービスタイプと認証方式を指定していることを確認してください。

ローカルユーザとリモート認証の設定については、オペレーションマニュアルのセクション 6 *セキュリティ “AAA”* を参照してください。

I. 制限事項とガイドライン

SSH ユーザを設定する際は、以下の制限事項とガイドラインに従ってください。

- SSH サーバは最大 16 人の SSH ユーザをサポートします。
- SSH ユーザの場合、ユーザロールは認証方式にも依存します。
  - 認証方式が **password** の場合、ユーザロールは AAA によって承認されます。
- ログイン中の SSH ユーザ認証パラメータを変更した場合、変更は次回ログイン時に有効になります。
- パスワード認証を除くすべての認証方式では、クライアントのホスト公開鍵を指定する必要があります。
  - ユーザの公開鍵情報を直接サーバに送信するクライアントの場合、サーバ上でクライアントのホスト公開鍵を指定します。指定する公開鍵は既に存在している必要があります。複数の公開鍵を指定した場合、装置は指定順序で公開鍵を使用してユーザ ID を検証します。ユーザは、いずれかの公開鍵チェックを通過すれば有効とみなされます。

II. 設定手順

SSH ユーザを設定し、サービスタイプと認証方式を指定するには：

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. SSH ユーザを作成し、サービスタイプと認証方式を指定する	**ssh user** *name* **authentication-method** { **password** | **publickey** *url* | **hostbased** *url* **host-name** *hostname* [*ip-address* | *ipv6-address*] }	—

2.2.7. SSH 管理パラメータの設定

操作	コマンド	補足
1. system view に移行する	**system-view**	—
2. SSH ユーザ認証タイムアウトタイマを設定する	**ip ssh** { **timeout** *seconds* | **authentication-retries** *number* }	デフォルト：120 秒 タイムアウトタイマが切れた時点でユーザが認証を完了していない場合、接続は確立されません。
3. SSH 認証の最大試行回数を設定する	**ip ssh** { **timeout** *seconds* | **authentication-retries** *number* }	デフォルト：3 回 認証の再試行回数を指定します。

2.3. SSHクライアントの設定

2.3.1. SSH クライアント設定作業リスト

設定リスト	
(必須設定項目)ローカル鍵ペアの作成	SSHサーバが認証方式として**publickey**または**password**を使用する場合、必須設定項目です。

2.3.2. ローカル鍵ペアの作成

SSH サーバが認証方式として **publickey** または **password** を使用する場合、SSH クライアント上でローカル鍵ペアを作成します。

I. 制限事項とガイドライン

SSH クライアントでローカル鍵ペアを作成する際は、以下の制限事項とガイドラインに従ってください。

- SSH のローカル DSA および RSA 鍵ペアはデフォルト名を使用します。鍵ペアに名前を割り当てることはできません。
- DSA 鍵ペアを作成する際、鍵モジュラス長は 2048 ビット未満でなければなりません。

II. 設定手順

SSH クライアントでローカル鍵ペアを作成するには:

操作	コマンド	補足
1. ローカル鍵ペアを作成する	**crypto key generate** { **rsa** [**modulus** *modulus-size*] | **dsa** }	デフォルト : SSHクライアント上にローカル鍵ペアは存在しません。

2.4. SFTPクライアントの設定

2.4.1. SFTP クライアント設定作業リスト

作業リスト	
(必須設定項目)ローカル鍵ペアの作成	SFTPサーバが認証方式として **publickey**、**password-publickey**、または**any**を使用する場合にのみ必須設定項目です。

2.4.2. ローカル鍵ペアの作成

SFTP サーバが認証方式として **publickey** または **password** の認証方式を使用する場合に、SFTP クライアント上でローカル鍵ペアを作成します。

I. 制限とガイドライン

SFTP クライアントでローカル鍵ペアを作成する際は、以下の制限事項とガイドラインに従ってください。

- SSH 用のローカル DSA、および RSA 鍵ペアはデフォルト名を使用します。鍵ペアに名前を割り当てることはできません。
- DSA 鍵ペアを作成する際、鍵のモジュラス長は 2048 ビット未満でなければなりません。

2.5. SSHの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
SSHサーバのステータスまたはセッションを表示する	**display ip ssh**
SSHサーバ上のSSHユーザ情報を表示する	**display ssh**
ローカル鍵ペアの公開鍵を表示する	**display crypto key mypubkey** { **rsa** | **dsa** }

2.6. SSH設定例

このセクションでは、Switch での SSH 設定例を示します。

2.6.1. パスワード認証を有効にした SSH サーバ設定例

I. ネットワーク要件

図 2-1 に示すように：

- Switch は SSH サーバとして機能し、パスワード認証を使用して SSH クライアントを認証します。クライアントのユーザ名とパスワードは Switch に保存されます。
- ホストは SSH クライアントとして機能し、SSH クライアントソフトウェア（SSH2）を使用します。ホスト上のユーザが SSH 経由で Switch にログインすると、ネットワーク管理者として Switch の設定や管理を行うことができます。

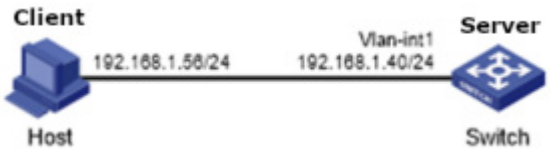

図 2-1 ネットワーク図

II. 設定手順

1. SSH サーバを設定します。

RSA 鍵ペアを作成します。

```
<Switch> crypto key generate rsa
Choose the size of the key modulus in the range of 512 to 2048. The process may take
a few
minutes.
Number of bits in the modulus [768]: 1024
Generating RSA key...Done.
```

DSA 鍵ペアを作成します。

```
<Switch> crypto key generate dsa
Generating DSA key...Done.
```

SSH サーバを有効化します。

```
<Switch> system-view
[Switch] ssh server enable
```

VLAN インタフェース 1 に IP アドレスを割り当てます。SSH クライアントはこのアドレスを SSH 接続の宛先として使用します。

```
[Switch] interface vlan-interface 1
[Switch-Vlan-interface1] ip address 182.168.1.40 24
[Switch-Vlan-interface1] quit
```

ユーザラインの認証モードをローカルに設定します。

```
[Switch] line vty 0 31
[Switch-line-vty0-31] authentication-mode scheme
[Switch-line-vty0-31] quit
```

ローカル装置管理ユーザ client001 を作成します。

```
[Switch] local-user client001
New local user added.
```

ローカルユーザ client001 のパスワードを平文で aabbcc2026dd2026 に設定します。

```
[Switch-luser-manage-client001] password simple aabbcc2026dd2026
```

ローカルユーザ client001 に SSH サービスの使用を許可します。

```
[Switch-luser-manage-client001] service-type ssh
```

ローカルユーザ client001 に **admin** ユーザロールを割り当てます。

```
[Switch-luser-manage-client001] authorization-attribute user-role admin
[Switch-luser-manage-client001] quit
```

client001 という名前の SSH ユーザを作成します。サービスのタイプを SSH、認証方式をパスワードとして指定します。

```
[Switch] ssh user client001 authentication-method password
```

2. SSH サーバへの接続を確立します。

   SSH クライアントソフトウェアには、PuTTY や OpenSSH など様々なタイプがあります。この例では、PuTTY バージョン 0.58 を実行する SSH クライアントを使用します。

   SSH サーバへの接続を確立するには：

   a. PuTTY.exe を起動し、図 2-2 に示すインタフェースを表示します。

   b. Host Name（or IP address）フィールドに、SSH サーバの IP アドレス 192.168.1.40 を入力します。

   c. Open をクリックします。

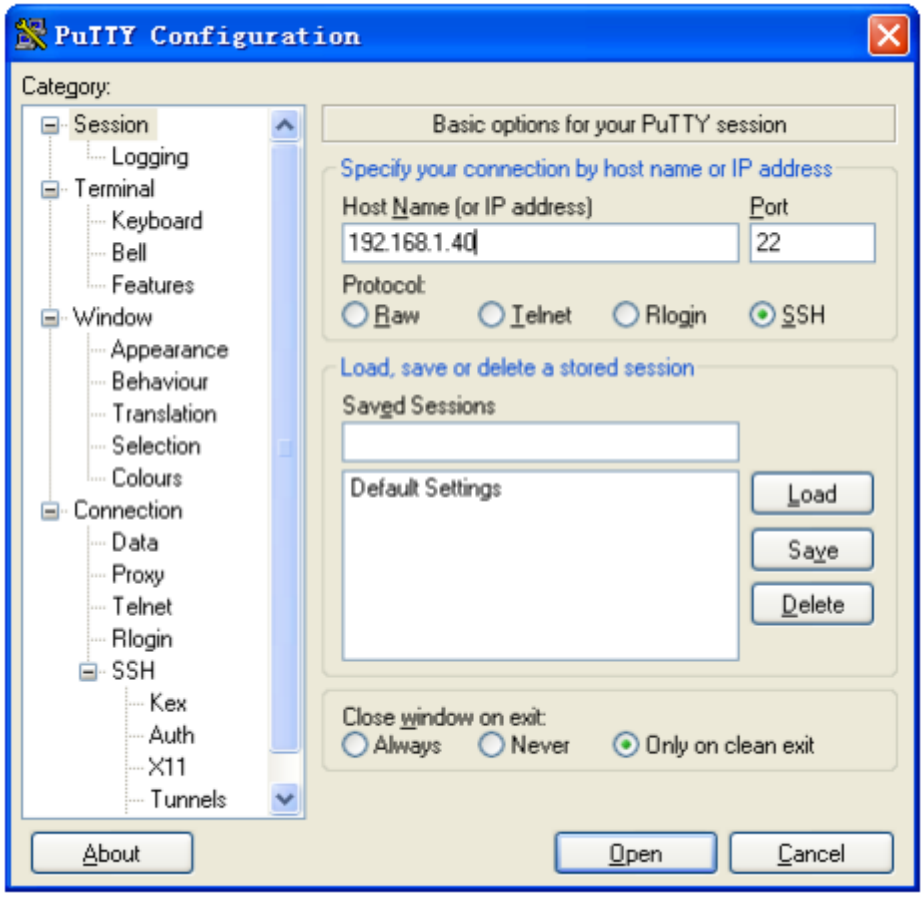

図 2-2 Host Name（or IP address）の指定

d. SSH サーバにログインするには、ユーザ名 client001 とパスワード aabbcc2026dd2026 を入力してください。

2.6.2. 公開鍵認証を有効にした SSH サーバ設定例

I. ネットワーク要件

図 2-3 に示すように：

- Switch は SSH サーバとして機能し、公開鍵認証と RSA 公開鍵アルゴリズムを使用します。
- ホストは SSH クライアントとして機能し、SSH クライアントソフトウェア（SSH2）を使用します。ホスト上のユーザが SSH 経由で Switch にログインした後、ネットワーク管理者として Switch を設定および管理できます。

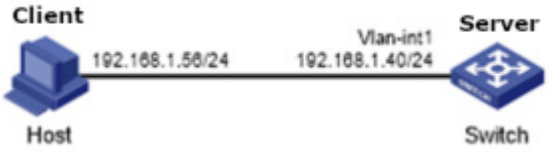

図 2-3 ネットワーク図

II. 設定手順

サーバ設定では、クライアントのホスト公開鍵が必要です。SSH サーバを設定する前に、クライアントソフトウェアを使用してクライアント上で RSA 鍵ペアを作成してください。

SSH クライアントソフトウェアには、PuTTY や OpenSSH など様々なタイプがあります。この例では、PuTTY バージョン 0.58 を実行する SSH クライアントを使用します。

設定手順は以下の通りです。

1. SSH クライアント上で RSA 鍵ペアを作成します。
   a. クライアントで PuTTYGen.exe を実行し、SSH-2 RSA を選択して Generate をクリックします。

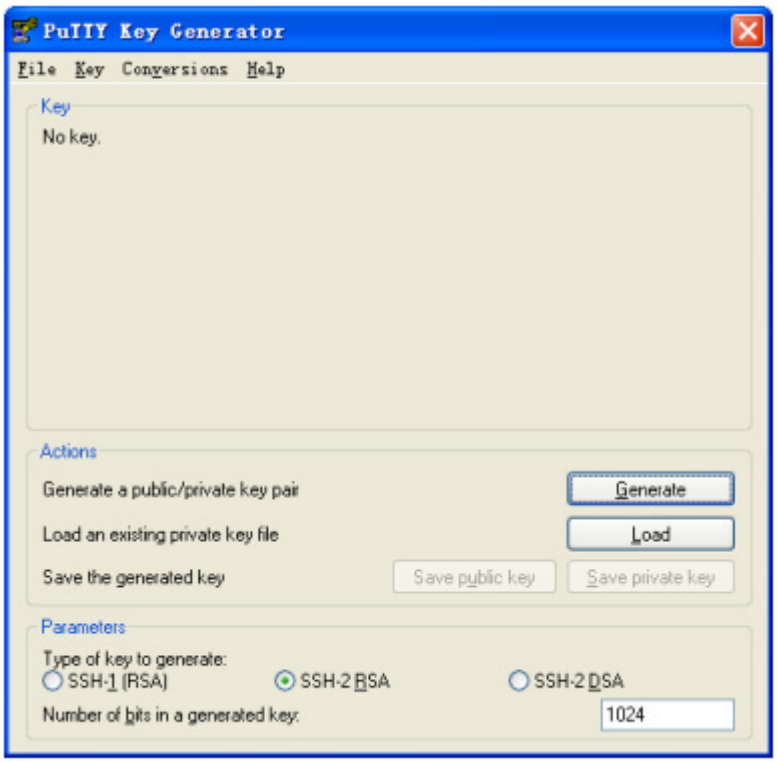

図 2-4 クライアントの鍵ペア作成

   b. 鍵作成プロセス中はマウスを動かし続けてください。ただし、図 2-5 に示す緑色の進行状況バーの上にマウスを置かないでください。そうすると進行状況バーの動きが止まり、鍵ペアの作成プロセスが中断します。

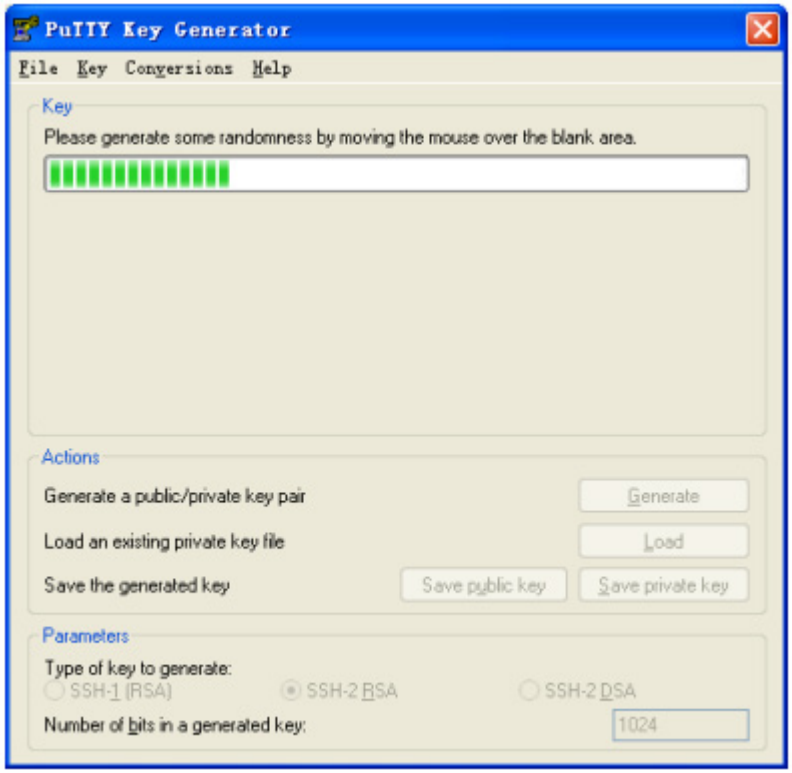

図 2-5 作成プロセス

c. 鍵ペアが作成されたら、**Save public key** をクリックして公開鍵を保存します。ファイル保存ウィンドウが表示されます。

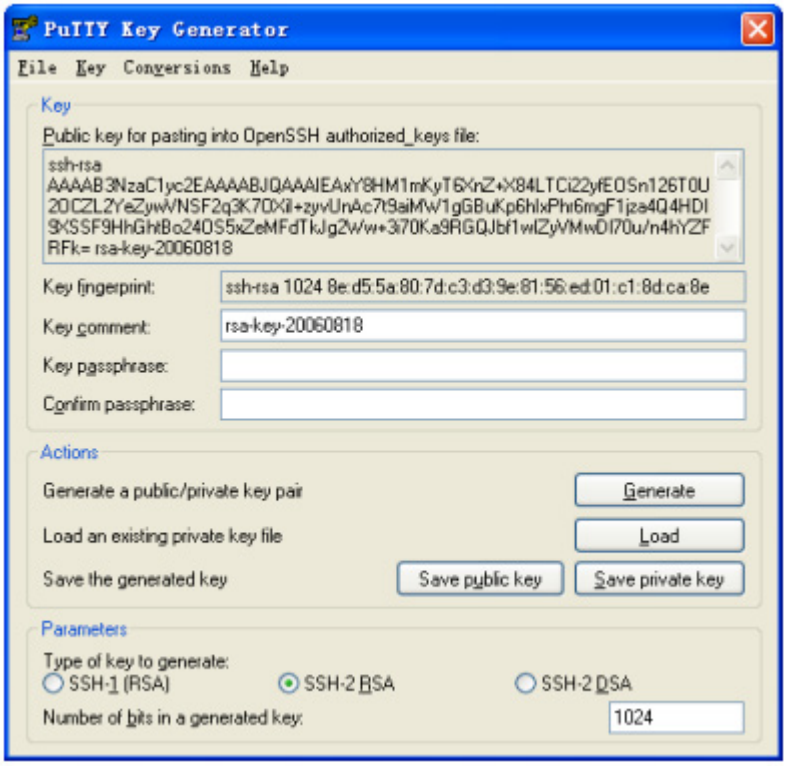

図 2-6 クライアントの鍵ペアの保存

d. ファイル名（この例では **key.pub**）を入力し、**Save** をクリックします。

e. 図 2-6 に示されるページで、**Save private key** をクリックして秘密鍵を保存します。確認ダイアログボックスが表示されます。

f. **Yes** をクリックします。

ファイル保存ウィンドウが表示されます。

g. ファイル名（この例では **private.ppk**）を入力し、**Save** をクリックします。

h. 公開鍵ファイルを FTP または TFTP 経由でサーバに転送します。（詳細は省略します）

2. SSH サーバを設定します。

RSA 鍵ペアを作成します。

```
<Switch> crypto key generate rsa
Choose the size of the key modulus in the range of 512 to 2048. The process may take
a few
minutes.
Number of bits in the modulus [768]: 1024
Generating RSA key...Done.
```

DSA 鍵ペアを作成します。

```
<Switch> crypto key generate dsa
Generating DSA key...Done.
```

SSH サーバを有効化します。

```
<Switch> system-view
[Switch] ssh server enable
```

VLAN インタフェース 1 に IP アドレスを割り当てます。SSH クライアントはこの IP アドレスを SSH 接続の宛先として使用します。

```
[Switch] interface vlan-interface 1
[Switch-Vlan-interface1] ip address 182.168.1.40 24
[Switch-Vlan-interface1] quit
```

ユーザラインの認証モードをローカルに設定します。

```
[Switch] line vty 0 31
[Switch-line-vty0-31] authentication-mode scheme
[Switch-line-vty0-31] quit
```

クライアントの公開鍵を公開鍵ファイル key.pub からインポートし、switchkey という名前で保存します。

```
<Switch> copy tftp: //182.168.1.40/key.pub flash: switchkey
```

client002 という名前の SSH ユーザを作成します。ユーザの認証方式を公開鍵認証に指定し、公開鍵 switchkey をユーザに割り当てます。

```
[Switch] ssh user client002 authentication-method publickey switchkey
```

ローカル装置管理ユーザ client002 を作成します。

```
[Switch] local-user client002
New local user added.
```

ローカルユーザ client002 に SSH サービスの使用を許可します。

```
[Switch-luser-manage-client002] service-type ssh
```

ローカルユーザ client002 に **admin** ユーザロールを割り当てます。

```
[Switch-luser-manage-client002] authorization-attribute user-role admin
[Switch-luser-manage-client002] quit
```

3. 秘密鍵ファイルを指定し、SSH サーバへの接続を確立します。
   a. SSH クライアントで PuTTY.exe を起動し、図 2-7 に示すインタフェースを表示します。
   b. **Host Name（or IP address）**フィールドに、SSH サーバの IP アドレス **192.168.1.40** を入力します。

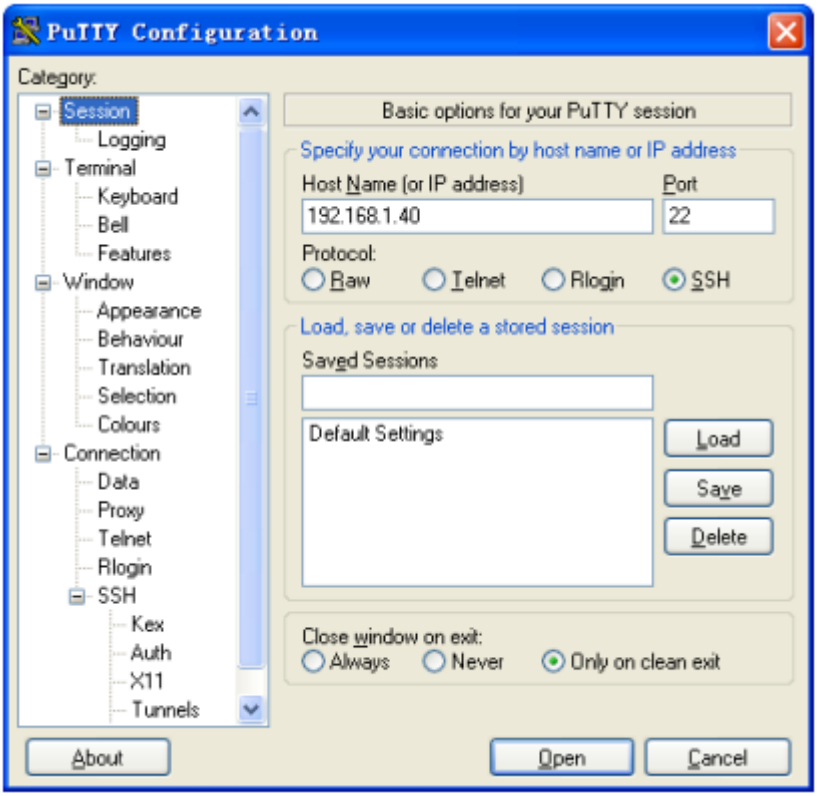

図 2-7 Host Name（or IP address）の指定

c. ナビゲーションツリーから、**Connection > SSH** を選択します。
　図 2-8 に示すウィンドウが表示されます。
d. **Preferred SSH protocol version** を **2** に設定します。

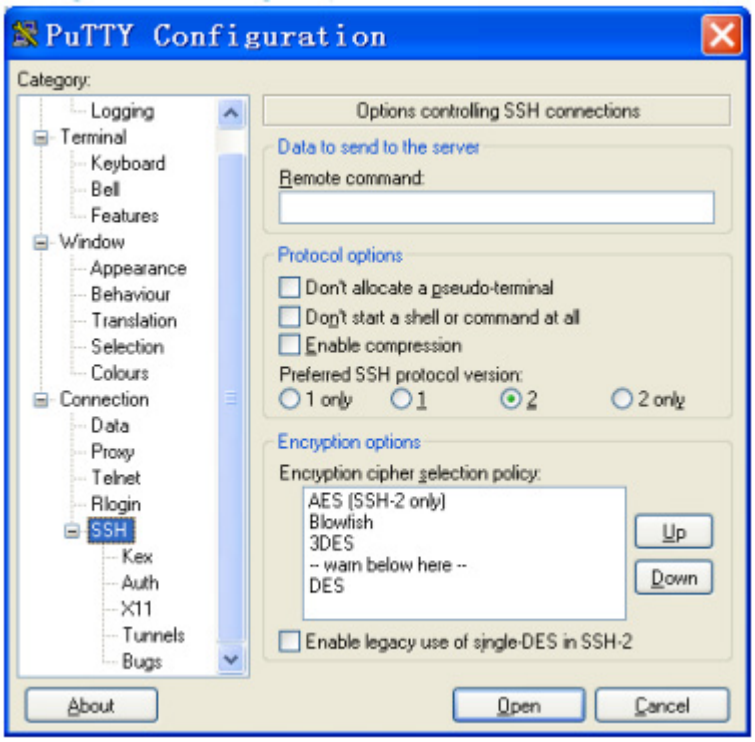

図 2-8 preferred SSH version の設定

e. ナビゲーションツリーから、**Connection > SSH > Auth** を選択します。
図 2-9 に示すウィンドウが表示されます。

f. **Browse…**をクリックしてファイル選択ウィンドウを開き、秘密鍵ファイル（この例では（**private.ppk**）を選択します。

g. **Open** をクリックします。

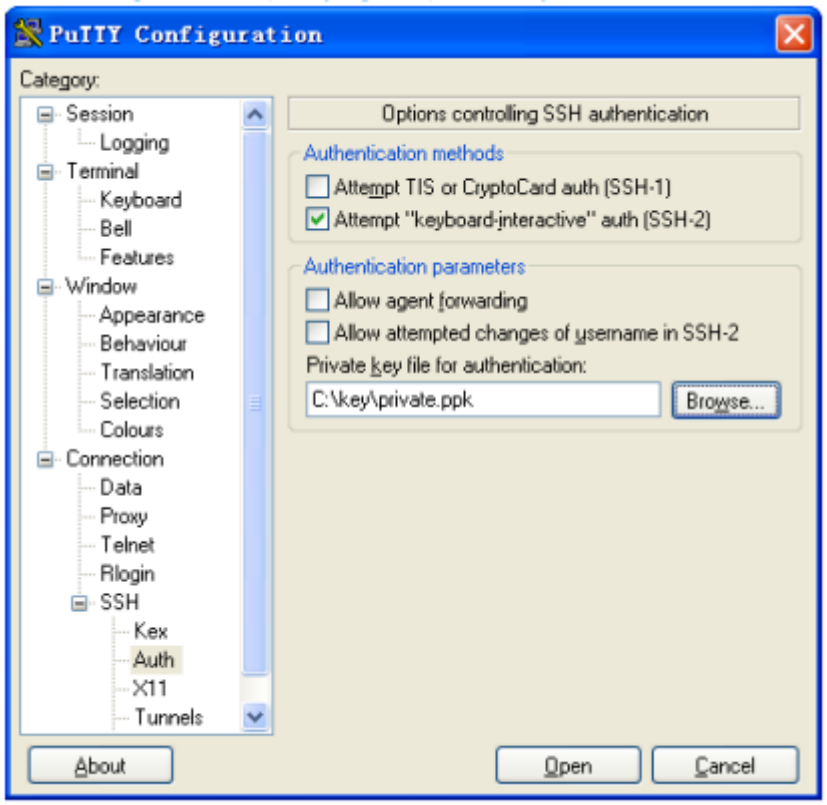

図 2-9 秘密鍵ファイルの指定

h. SSH サーバへのログインにユーザ名 **client002** を入力します。

2.6.3. パスワード認証を有効にした SSH クライアント設定例

I. ネットワーク要件

図 2-10 に示すように：

- Switch B は SSH サーバとして機能し、パスワード認証を使用して SSH クライアントを認証します。クライアントのユーザ名とパスワードは Switch B に保存されます。
- Switch A は SSH クライアントとして機能します。Switch A のユーザが SSH 経由で Switch B にログインした後、ネットワーク管理者として Switch B を設定および管理できます。

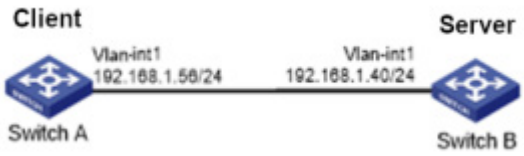

図 2-10 ネットワーク図

II. 設定手順

1. SSH サーバを設定します。

RSA 鍵ペアを作成します。

```
<SwitchB> crypto key generate rsa
Choose the size of the key modulus in the range of 512 to 2048. The process may take a few
minutes.
Number of bits in the modulus [768]: 1024
Generating RSA key...Done.
```

DSA 鍵ペアを作成します。

```
<SwitchB> crypto key generate dsa
Generating DSA key...Done.
```

SSH サーバを有効化します。

```
[SwitchB] ssh server enable
```

VLAN インタフェース 1 に IP アドレスを割り当てます。SSH クライアントはこのアドレスを SSH 接続の宛先アドレスとして使用します。

```
[SwitchB] interface vlan-interface 1
[SwitchB-Vlan-interface1] ip address 192.168.1.40 255.255.255.0
[SwitchB-Vlan-interface1] quit
```

ユーザラインの認証モードをローカルに設定します。

```
[SwitchB] line vty 0 31
[SwitchB-line-vty0-31] authentication-mode scheme
[SwitchB-line-vty0-31] quit
```

ローカル装置管理ユーザ client001 を作成します。

```
[SwitchB] local-user client001
New local user added.
```

ローカルユーザ client001 のパスワードを平文で aabbcc2026dd2026 に設定します。

```
[SwitchB-luser-manage-client001] password simple aabbcc2026dd2026
```

ローカルユーザ client001 に SSH サービスの使用を許可します。

```
[SwitchB-luser-manage-client001] service-type ssh
```

ローカルユーザ client001 に admin ユーザロールを割り当てます。

```
[SwitchB-luser-manage-client001] authorization-attribute user-role admin
[SwitchB-luser-manage-client001] quit
```

client001 という名前の SSH ユーザを作成します。サービスのタイプを SSH、認証方式をパスワードとして指定します。

```
[SwitchB] ssh user client001 authentication-method password
```

2. SSH サーバへの接続を確立します

VLAN インタフェース 1 に IP アドレスを割り当てます。

```
<SwitchA> system-view
[SwitchA] interface vlan-interface 1
[SwitchA-Vlan-interface2] ip address 192.168.1.56 255.255.255.0
[SwitchA-Vlan-interface2] quit
```

```
[SwitchA] quit
 # Establish an SSH connection to the server.
<SwitchA> ssh -l client001 192.168.1.40
client001@192.168.1.40's password: ********
```

ユーザ名 client001 とパスワード aabbcc2026dd2026 を入力すると、Switch B に正常にログインできます。

2.6.4. 公開鍵認証を有効にした SSH クライアント設定例

I. ネットワーク要件

図 2-11 に示すように：

- Switch B は SSH サーバとして機能し、公開鍵認証と DSA 公開鍵アルゴリズムを使用します。
- Switch A は SSH クライアントとして機能します。Switch A のユーザが SSH 経由で Switch B にログインした後、ネットワーク管理者として Switch B を設定および管理できます。

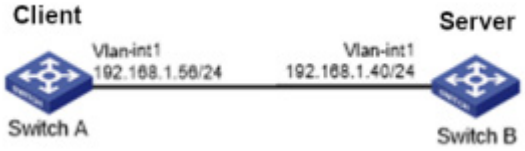

図 2-11 ネットワーク図

II. 設定手順

サーバ設定では、クライアントのホスト公開鍵が必要です。SSH サーバを設定する前に、クライアントで DSA 鍵ペアを作成してください。

1. SSH クライアントを設定します。

VLAN インタフェース 1 に IP アドレスを割り当てます。

```
<SwitchA> system-view
[SwitchA] interface vlan-interface 1
[SwitchA-Vlan-interface1] ip address 192.168.1.56 255.255.255.0
[SwitchA-Vlan-interface1] quit
```

クライアント Switch で認証方式を公開鍵に設定します。

```
[SwitchA] ip ssh client authmethod publickey
```

RSA 鍵ペアをクライアント Switch にダウンロードし、公開鍵と秘密鍵のパスを設定します。

```
<SwitchA>copy tftp: //192.168.1.126/Identity.pub flash: Identity.pub
Address of remote host [192.168.1.126]?
Source filename [Identity.pub]?
Destination filename [Identity.pub]?
Accessing tftp://192.168.1.126/Identity.pub...
Transmission start...
Transmission finished, file length 609 bytes.
Please wait, programming flash.............. Done.
<SwitchA>
```

```
<SwitchA>copy tftp: //192.168.1.126/Identity flash: Identity
Address of remote host [192.168.1.126]?
Source filename [Identity]?
Destination filename [Identity]?
Accessing tftp://192.168.1.126/Identity...
Transmission start...
Transmission finished, file length 680 bytes.
Please wait, programming flash.............. Done.
<SwitchA>
[SwitchA] ip ssh client keypath publickey /c:/Identity.pub
[SwitchA] ip ssh client keypath privatekey /c:/Identity
```

2. SSH サーバを設定します。

RSA 鍵ペアを作成します。

```
<SwitchB> crypto key generate rsa
Choose the size of the key modulus in the range of 512 to 2048. The process may take
a few
minutes.
Number of bits in the modulus [768]: 1024
Generating RSA key...Done.
```

DSA 鍵ペアを作成します。

```
<SwitchB> crypto key generate dsa
Generating DSA key...Done.
```

SSH サーバを有効化します。

```
[SwitchB] ssh server enable
```

VLAN インタフェース 1 に IP アドレスを割り当てます。SSH クライアントはこのアドレスを SSH 接続の宛先アドレスとして使用します。

```
[SwitchB] interface vlan-interface 1
[SwitchB-Vlan-interface1] ip address 192.168.1.40 255.255.255.0
[SwitchB-Vlan-interface1] quit
```

ユーザラインの認証モードをローカルに設定します。

```
[SwitchB] line vty 0 31
[SwitchB-line-vty0-31] authentication-mode scheme
[SwitchB-line-vty0-31] quit
```

client002 という名前の SSH ユーザを作成します。ユーザの認証方式を公開鍵認証に指定します。公開鍵 Identity.pub をユーザに割り当てます。

```
[SwitchB] ssh user client002 authentication-method publickey /c:/Identity.pub
```

ローカル装置管理ユーザ client002 を作成します。

```
[SwitchB] local-user client002
New local user added.
```

ローカルユーザ client002 に SSH サービスの使用を許可します。

```
[SwitchB-luser-manage-client002] service-type ssh
```

ローカルユーザ client002 に admin ユーザロールを割り当てます。

```
[SwitchB-luser-manage-client002] authorization-attribute user-role admin
```

```
[SwitchB-luser-manage-client002] quit
```

3. SSH サーバへの SSH 接続を確立します。

```
<SwitchA> ssh -l client002 192.168.1.40
<SwitchA>
```

2.7. SFTP設定例

このセクションでは、Switch での SFTP 設定例を示します。

2.7.1. パスワード認証を有効にした SFTP サーバ設定例

I. ネットワーク要件

図 2-12 に示すように：

- Switch は SFTP サーバとして機能し、パスワード認証を使用して SFTP クライアントを認証します。クライアントのユーザ名とパスワードは Switch に保存されます。
- ホストは SFTP クライアントとして機能します。クライアント側のユーザが SFTP 経由で Switch にログインすると、ネットワーク管理者として Switch 上でファイル管理や転送操作を実行できます。

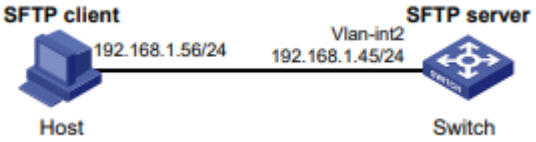

図 2-12 ネットワーク図

II. 設定手順

1. SFTP サーバを設定します。

RSA 鍵ペアを作成します。

```
<Switch> crypto key generate rsa
Choose the size of the key modulus in the range of 512 to 2048. The process may take
a few
minutes.
Number of bits in the modulus [768]: 1024
Generating RSA key...Done.
```

DSA 鍵ペアを作成します。

```
<Switch> crypto key generate dsa
Generating DSA key...Done.
```

SFTP サーバを有効化します。

```
[Switch] sftp server enable
```

VLAN インタフェース 2 に IP アドレスを割り当てます。クライアントはこのアドレスを SSH 接続の宛先として使用します。

```
[Switch] interface vlan-interface 2
[Switch-Vlan-interface2] ip address 192.168.1.45 255.255.255.0
[Switch-Vlan-interface2] quit
```

ローカル装置管理ユーザ **client002** を作成します。

```
[Switch] local-user client002 class manage
```

ローカルユーザ **client002** のパスワードを平文で **aabbcc2026** に設定します。

```
[Switch-luser-manage-client002] password simple aabbcc2026
```

ローカルユーザ **client002** に SSH サービスの使用を許可します。

```
[Switch-luser-manage-client002] service-type ssh
```

ローカルユーザ **client002** に **admin** ユーザロールと作業ディレクトリ **flash:/**を割り当てます。

```
[Switch-luser-manage-client002] authorization-attribute user-role admin
work-directory flash:/
[Switch-luser-manage-client002] quit
```

SSH ユーザ **client002** を作成します。認証方式を **password**、サービスタイプを **sftp** として指定します。

```
[Switch] ssh user client002 service-type sftp authentication-type password
```

2. SFTP クライアントと SFTP サーバ間の接続を確立します。

   本装置は各種 SFTP クライアントソフトウェアに対応しています。この例では PuTTy バージョン 0.58 の PSFTP を実行する SFTP クライアントを使用します。

メモ:

PSFTP はパスワード認証のみをサポートします。

SFTP サーバへの接続を確立するには：

a. **psftp.exe** を実行して図 2-13 に示すクライアントインタフェースを起動し、以下のコマンドを入力します。

```
open 192.168.1.45
```

b. SFTP サーバにログインするには、ユーザ名 **client002** とパスワード **aabbcc2026** を入力します。

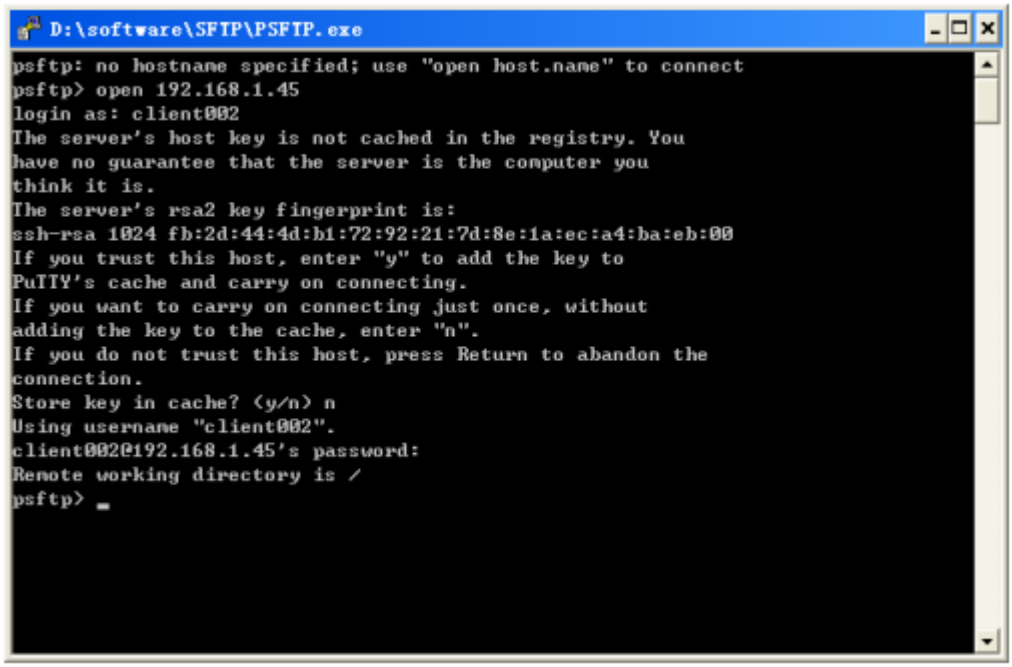

図 2-13 SFTP クライアントインタフェース

2.7.2. 公開鍵認証を有効にした SFTP クライアント設定例

I. ネットワーク要件

図 2-14 に示すように：

- Switch B はSFTPサーバとして機能し、公開鍵認証と RSA 公開鍵アルゴリズムを使用します。
- Switch A は SFTP クライアントとして機能します。Switch A のユーザが SFTP 経由で Switch B にログインすると、ネットワーク管理者として Switch B 上でファイル管理や転送操作を実行できます。

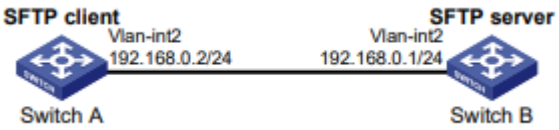

図 2-14 ネットワーク図

II. 設定手順

サーバ設定では、クライアントのホスト公開鍵が必要です。SFTP サーバを設定する前に、クライアントで RSA 鍵ペアを作成してください。

1. SFTP クライアントを設定します。

VLAN インタフェース 2 に IP アドレスを割り当てます。

```
<SwitchA> system-view
[SwitchA] interface vlan-interface 2
```

```
[SwitchA-Vlan-interface2] ip address 192.168.0.2 255.255.255.0
[SwitchA-Vlan-interface2] quit
```

RSA 鍵ペアを作成します。

```
<SwitchA> crypto key generate rsa
Choose the size of the key modulus in the range of 512 to 2048. The process may take a few minutes.
Number of bits in the modulus [768]: 1024
Generating RSA key...Done.
```

ホスト公開鍵を **pubkey** という名前の公開鍵ファイルにエクスポートします。

```
[SwitchA] public-key local export rsa ssh2 pubkey
[SwitchA] quit
```

公開鍵ファイル **pubkey** を FTP または TFTP 経由でサーバに転送します。（詳細は省略します）

2. SFTP サーバを設定します。

RSA 鍵ペアを作成します。

```
<SwitchB> crypto key generate rsa
Choose the size of the key modulus in the range of 512 to 2048. The process may take a few minutes.
Number of bits in the modulus [768]: 1024
Generating RSA key...Done.
```

DSA 鍵ペアを作成します。

```
<SwitchB> crypto key generate dsa
Generating DSA key...Done.
```

SFTP サーバを有効化します。

```
[SwitchB] sftp server enable
```

VLAN インタフェース 2 に IP アドレスを割り当てます。SSH クライアントはこのアドレスを SSH 接続の宛先として使用します。

```
[SwitchB] interface vlan-interface 2
[SwitchB-Vlan-interface2] ip address 192.168.0.1 255.255.255.0
[SwitchB-Vlan-interface2] quit
```

公開鍵ファイル **pubkey** からピア公開鍵をインポートし、**switchkey** という名前で保存します。

```
[SwitchB] public-key peer switchkey import sshkey pubkey
```

client001 という名前の SSH ユーザを作成します。サービスのタイプを **sftp**、認証方式を **publickey** と指定します。ユーザに公開鍵 **switchkey** を割り当てます。

```
[SwitchB] ssh user client001 service-type sftp authentication-type publickey assign publickey switchkey
```

ローカル装置管理ユーザ **client001** を作成します。

```
[SwitchB] local-user client001 class manage
```

ローカルユーザ **client001** に SSH サービスの使用を許可します。

```
[SwitchB-luser-manage-client001] service-type ssh
```

ローカルユーザ **client001** に **admin** ユーザロールと作業ディレクトリ flash:/を割り当てます。

```
[SwitchB-luser-manage-client001] authorization-attribute user-role admin
```

```
work-directory flash:/
[SwitchB-luser-manage-client001] quit
```

3. SFTP サーバへの接続を確立します。

SFTP サーバに接続し、SFTP client view に移行します。

```
<SwitchA> sftp 192.168.0.1 identity-key rsa
Username: client001
Press CTRL+C to abort.
Connecting to 192.168.0.1 port 22.
The server is not authenticated. Continue? [Y/N]:y
Do you want to save the server public key? [Y/N]:n
sftp>
```

サーバの現在のディレクトリ下のファイルを表示し、ファイル z を削除して結果を確認します。

```
sftp> dir -l
-rwxrwxrwx 1 noone nogroup 1759 Aug 23 06:52 config.cfg
-rwxrwxrwx 1 noone nogroup 225 Aug 24 08:01 pubkey2
-rwxrwxrwx 1 noone nogroup 283 Aug 24 07:39 pubkey
drwxrwxrwx 1 noone nogroup 0 Sep 01 06:22 new
-rwxrwxrwx 1 noone nogroup 225 Sep 01 06:55 pub
-rwxrwxrwx 1 noone nogroup 0 Sep 01 08:00 z
sftp> delete z
Removing /z
sftp> dir -l
-rwxrwxrwx 1 noone nogroup 1759 Aug 23 06:52 config.cfg
-rwxrwxrwx 1 noone nogroup 225 Aug 24 08:01 pubkey2
-rwxrwxrwx 1 noone nogroup 283 Aug 24 07:39 pubkey
drwxrwxrwx 1 noone nogroup 0 Sep 01 06:22 new
-rwxrwxrwx 1 noone nogroup 225 Sep 01 06:55 pub
```

new1 というディレクトリを追加し、結果を確認します。

```
sftp> mkdir new1
sftp> dir -l
-rwxrwxrwx 1 noone nogroup 1759 Aug 23 06:52 config.cfg
-rwxrwxrwx 1 noone nogroup 225 Aug 24 08:01 pubkey2
-rwxrwxrwx 1 noone nogroup 283 Aug 24 07:39 pubkey
drwxrwxrwx 1 noone nogroup 0 Sep 01 06:22 new
-rwxrwxrwx 1 noone nogroup 225 Sep 01 06:55 pub
drwxrwxrwx 1 noone nogroup 0 Sep 02 06:30 new1
```

new1 ディレクトリの名前を **new2** に変更し、結果を確認します。

```
sftp> rename new1 new2
sftp> dir -l
-rwxrwxrwx 1 noone nogroup 1759 Aug 23 06:52 config.cfg
-rwxrwxrwx 1 noone nogroup 225 Aug 24 08:01 pubkey2
-rwxrwxrwx 1 noone nogroup 283 Aug 24 07:39 pubkey
drwxrwxrwx 1 noone nogroup 0 Sep 01 06:22 new
-rwxrwxrwx 1 noone nogroup 225 Sep 01 06:55 pub
```

```
drwxrwxrwx 1 noone nogroup 0 Sep 02 06:33 new2
```

サーバからファイル **pubkey2** をダウンロードし、ローカルファイル **public** として保存します。

```
sftp> get pubkey2 public
Fetching / pubkey2 to public
/pubkey2 100% 225 1.4KB/s 00:00
```

ローカルファイル **pu** をサーバにアップロードし、**puk** として保存して結果を確認します。

```
sftp> put pu puk
Uploading pu to / puk
sftp> dir -l
-rwxrwxrwx 1 noone nogroup 1759 Aug 23 06:52 config.cfg
-rwxrwxrwx 1 noone nogroup 225 Aug 24 08:01 pubkey2
-rwxrwxrwx 1 noone nogroup 283 Aug 24 07:39 pubkey
drwxrwxrwx 1 noone nogroup 0 Sep 01 06:22 new
drwxrwxrwx 1 noone nogroup 0 Sep 02 06:33 new2
-rwxrwxrwx 1 noone nogroup 283 Sep 02 06:35 pub
-rwxrwxrwx 1 noone nogroup 283 Sep 02 06:36 puk
sftp>
```

SFTP client view を終了します。

```
sftp> quit
<SwitchA>
```

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

7. システム管理

本マニュアルは以下に示す章で構成されています。

01-システムの保守とデバッグ

02-NTP

03-Information Center

04-SNMP

05-PoE

06-NetMeister

07-NQA

目次

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1.1.2. Ping 設定例 ····· 1-1
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1章　システムの保守とデバッグ

> 🕮 メモ：
> IPv6 機能は現在のソフトウェアではサポートしていません。

この章では、ping、tracert およびシステムのデバッグ情報について記載します。

1.1. Ping

ping ユーティリティを使用して、アドレスが到達可能かどうかを判断します。

Ping は宛先装置に ICMP エコー要求（ECHO-REQUEST）を送信します。要求を受信すると、宛先装置は ICMP エコー応答（ECHO-REPLY）を送信元装置に返します。送信元装置は、送信したパケット数、受信したエコー応答数、往復時間などの Ping 操作に関する統計情報を出力します。これらの統計情報を分析することで、ネットワークのパフォーマンスを測定できます。

1.1.1. ping コマンドを使用したネットワーク接続テスト

すべての view で **ping** コマンドを実行できます。

操作	コマンド	補足
IPネットワーク内のアドレスが到達可能かどうかを判断する	**ping** { [**ip**] *ip-address* | [**ipv6**] *ipv6-address* | *host-name* } [**count** *times*] [**timeout** *seconds*] [**length** *length*] [**tos** *tos*] [**source** { *ip-address* | *ipv6-address* }]	低速ネットワークで**ping**コマンドを使用する場合、タイムアウト時間（**timeout**キーワード）を大きな値に設定してください。

1.1.2. Ping 設定例

I. ネットワーク要件

図 1-1 に示すように、Device A と Device C が相互に到達可能かどうかを判断します。到達可能な場合、Device A から Device C へのルートに関する詳細情報を取得します。

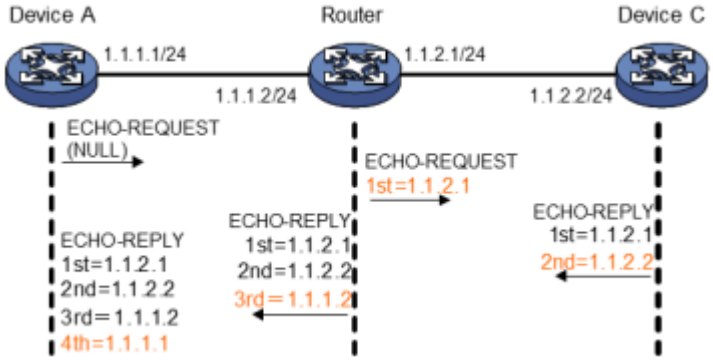

図 1-1 ネットワーク図

II. 設定手順

Device A で ping コマンドを使用し、Device C への接続性をテストします。

```
<Switch> ping 1.1.2.2
PING 1.1.2.2 (1.1.2.2) 56(84) bytes of data.
64 bytes from 1.1.2.2: icmp_seq=1 ttl=63 time=1.22 ms
64 bytes from 1.1.2.2: icmp_seq=2 ttl=63 time=1.11 ms
64 bytes from 1.1.2.2: icmp_seq=3 ttl=63 time=1.13 ms
64 bytes from 1.1.2.2: icmp_seq=4 ttl=63 time=1.10 ms
64 bytes from 1.1.2.2: icmp_seq=5 ttl=63 time=1.09 ms
--- 1.1.2.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4004ms
rtt min/avg/max/mdev = 1.092/1.128/1.224/0.048 ms
<Switch>
```

出力には以下の情報が表示されます。

- Device A が Device C に 5 つの ICMP パケットを送信し、Device A が 5 つの ICMP パケットを受信します。
- ICMP パケットの損失はありません。
- ルートは到達可能です。

1.2. Tracert

Tracert（Traceroute とも呼ばれる）は、宛先までの経路にあるレイヤ 3 装置の IP アドレスを取得します。ネットワーク障害が発生した場合、tracert を使用してネットワーク接続性をテストし、障害が発生したノードを特定します。

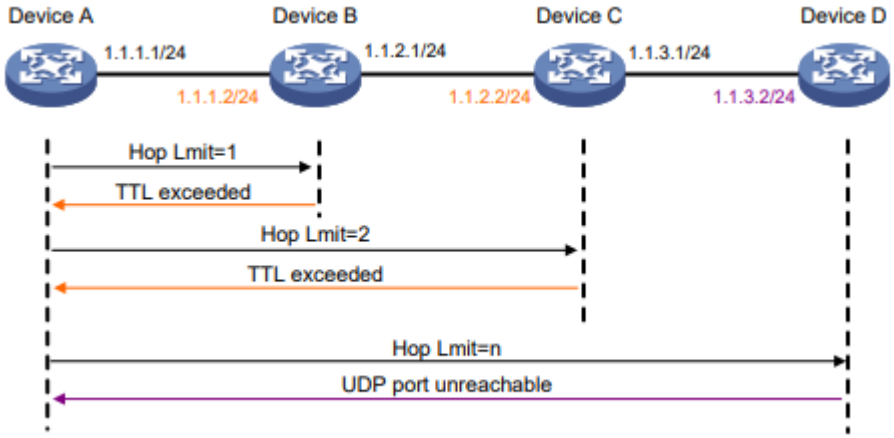

図 1-2 Tracert の動作

Tracert は受信した ICMP エラーメッセージを使用して装置の IP アドレスを取得します。Tracert の動作は図 1-2 に示す通りです。

1. 送信元装置は、TTL 値 1 の UDP パケットを宛先装置に送信します。宛先 UDP ポートは、宛先装置上のどのアプリケーションにも使用されていません。
2. 最初のホップ（Device B、パケットを受信する最初のレイヤ 3 装置）は、送信元に対して TTL 切れの ICMP エラーメッセージを返信します。このメッセージには送信元装置自身の IP アドレス（1.1.1.2）がカプセル化されています。これにより、送信元装置は最初のレイヤ 3 装置のアドレス（1.1.1.2）を取得できます。
3. 送信元装置は、宛先装置に向けて TTL 値を 2 に設定したパケットを送信します。
4. 第 2 ホップ（Device C）は TTL 切れの ICMP エラーメッセージで応答し、これにより送信元装置は第 2 のレイヤ 3 装置（1.1.2.2）のアドレスを取得します。
5. このプロセスは、送信元装置が送信したパケットが最終的な宛先装置に到達するまで継続されます。パケットで指定された宛先ポートを使用するアプリケーションが存在しないため、宛先装置はポート到達不能の ICMP メッセージを送信元装置に返信し、その IP アドレスをカプセル化します。これにより、送信元装置は宛先装置の IP アドレス（1.1.3.2）を取得します。
6. 送信元装置は以下を判断します。
   - ポート到達不能の ICMP メッセージを受信した時点で、パケットが宛先装置に到達したことを認識します。
   - 宛先装置へのパスは 1.1.1.2 から 1.1.2.2 へ、そして 1.1.3.2 です。

1.2.1. 前提条件

tracert コマンドを使用する前に、このセクションの作業を実行してください。

IPv4 ネットワークの場合：

- 中間装置（送信元装置と宛先装置間の装置）で ICMP タイムアウトパケットの送信を有効にします。中間装置が QX シリーズの場合、該当装置で **ip ttl-expires enable** コマンドを実行します。
- 宛先装置で ICMP 宛先到達不能パケットの送信を有効にします。宛先装置が QX シリーズの場合、**ip unreachables enable** コマンドを実行します。

IPv6 ネットワークの場合：

- 中間装置（送信元装置と宛先装置間の装置）で ICMPv6 タイムアウトパケットの送信を有効化します。中間装置が QX シリーズの場合、各装置で **ipv6 hoplimit-expires enable** コマンドを実行します。
- 宛先装置で ICMPv6 宛先到達不能パケットの送信を有効にします。宛先装置が QX シリーズの場合、**ipv6 unreachables enable** コマンドを実行します。

1.2.2. パス上の障害発生ノードまたは全ノードを特定するための tracert コマンドの使用

すべての view で **tracert** コマンドを実行できます。

操作	コマンド
送信元から宛先までのルートを表示する	**traceroute** { [**ip**] *ip-address* | [**ipv6**] *ipv6-address* | *host-name* } [**probe** *number*] [**timeout** *seconds*] [**max-ttl** *ttl*] [**port** *dest-port*] [**source** { *ip-address* | *ipv6-address* }] [**length** *length*] [**tos** *tos*]

1.2.3. Tracert 設定例

I. ネットワーク要件

図 1-3 に示すように、Device A は Device C への Telnet に失敗しました。

Device A と Device C 間のネットワーク接続性をテストします。相互に到達できない場合、ネットワーク内の障害ノードを特定します。

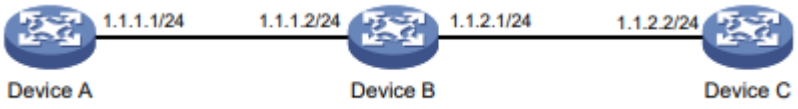

図 1-3 ネットワーク図

II. 設定手順

1. 図 1-3 に示すように、装置の IP アドレスを設定します。
2. Device A にデフォルトルートを設定します。

```
<Switch> system-view
[Switch] ip route-static 0.0.0.0 0.0.0.0 1.1.1.2
[Switch] quit
```

3. **ping** コマンドを使用して、Device A と Device C 間の接続性をテストします。

```
<Switch> ping 1.1.2.2 count 5
PING 1.1.2.2 (1.1.2.2) 56(84) bytes of data.
--- 1.1.2.2 ping statistics ---
5 packets transmitted, 0 received, 100% packet loss, time 4092ms
<Switch>
```

出力結果から、Device A と Device C は相互に到達できないことがわかります。

4. 障害ノードを特定するには **tracert** コマンドを使用します。

```
<Switch> traceroute 1.1.2.2
traceroute to 1.1.2.2 (1.1.2.2), 30 hops max, 60 byte packets
1 1.1.1.2 2.706 ms 3.354 ms 4.104 ms
2 * * *
3 * * *
4 * * *
5 * * *
6 * * *
7 * * *
8 * * *
9 * * *
10 * * *
11 * * *
12 * *
<Switch>
```

出力結果から、Device A はルータには到達できるが Device C には到達できないことがわかります。ルータと Device C 間の接続でエラーが発生しています。

5. 問題の原因を特定するには、Device A と Device C で以下のコマンドを実行してください。
   - **display ip route** コマンドを実行し、Device A と Device C が相互に到達可能なルートを持っていることを確認してください。

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2章 NTP

> 🕮 メモ：
> IPv6 アドレスは現在のソフトウェアではサポートしていません。

2.1. 概要

NTP は通常、大規模ネットワークにおいてネットワーク装置間で動的に時刻を同期するために使用されます。手動でのシステムクロック設定よりも高いクロック精度を保証します。高いクロック精度を必要としない小規模ネットワークでは、装置ごとにシステムクロックを変更することで、装置間の時刻同期を維持できます。

NTP は UDP 上で動作し、UDP ポート 123 を使用します。

2.1.1. NTP の動作

図 2-1 は、NTP が 2 つの装置（この例では Device A と Device B）間でシステム時刻を同期させる仕組みを示しています。以下の前提条件を想定します。

- 時刻同期前に、Device A の時刻は午前 10:00:00、Device B の時刻は午前 11:00:00 に設定されています。
- Device B を NTP サーバとして使用します。Device A は Device B に同期されます。
- NTP メッセージが Device A から Device B へ、そして Device B から Device A へ伝播するのに 1 秒かかります。
- Device B が NTP メッセージを処理するのに 1 秒かかります。

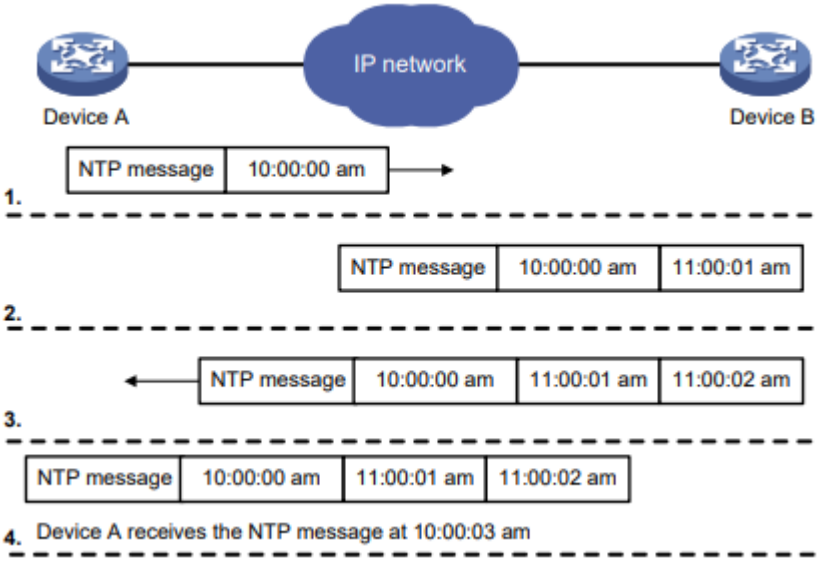

図 2-1 基本ワークフロー

同期プロセスは以下の通りです。

1. Device A は Device B に NTP メッセージを送信します。このメッセージは Device A を出発した時点でタイムスタンプが付けられます。タイムスタンプは午前 10 時 00 分 00 秒（T1）です。
2. この NTP メッセージが Device B に到着すると、Device B はメッセージ到着時刻を示すタイムスタンプを追加します。タイムスタンプは午前 11 時 00 分 01 秒（T2）です。
3. NTP メッセージが Device B を離れる際、Device B はメッセージが Device B を離れた時刻を示すタイムスタンプを追加します。このタイムスタンプは午前 11 時 00 分 02 秒（T3）です。
4. Device A が NTP メッセージを受信したとき、Device A のローカル時刻は午前 10 時 00 分 03 秒（T4）です。

これまでに、Device A は以下のタイムスタンプに基づいて以下のパラメータを計算できます。

- NTP メッセージの往復遅延：遅延 = (T4 - T1) - (T3 - T2) = 2 秒
- Device A と Device B の時間差：オフセット = ((T2 - T1) + (T3 - T4)) /2 = 1 時間

これらのパラメータに基づき、Device A は Device B に同期させることができます。

上記は、NTP の動作メカニズムについての概要です。詳細については、関連するプロトコルと標準を参照してください。

2.1.2. NTP アーキテクチャ

NTP は図 2-2 に示すように、stratum1～16 を用いてクロックの精度を定義します。stratum 値が低いほど精度が高いことを示します。stratum1～15 のクロックは同期状態にあり、stratum16 のクロックは同期されていません。

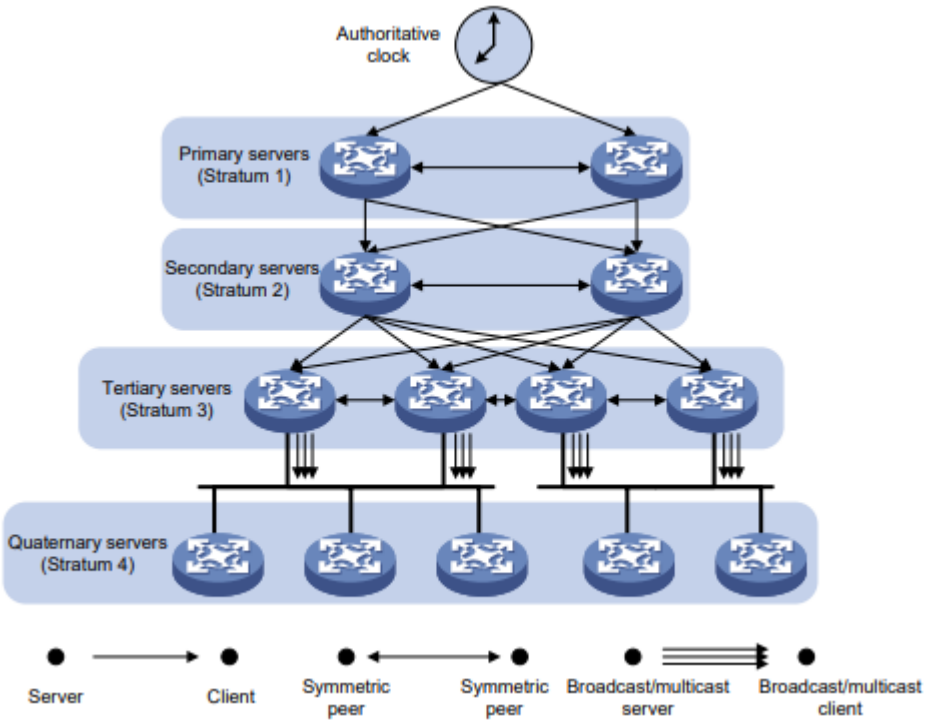

図 2-2 NTP アーキテクチャ

stratum 1 NTP サーバは、原子時計などの権威ある時刻ソースから時刻を取得します。プライマリ NTP サーバとして他の装置に時刻を提供します。stratum 2 時刻サーバは stratum 1 時刻サーバから時刻を取得します。以下同様です。

時刻の正確性と可用性を確保するため、装置に複数の NTP サーバを指定できます。装置は stratum などのパラメータに基づき、最適な NTP サーバをクロックソースとして選択します。装置が選択したクロックは参照ソースと呼ばれます。

ネットワーク内の装置が権威ある時刻ソースに同期できない場合、以下の作業を実行できます。

- ネットワーク内で比較的正確なクロックを持つ装置を選択します。
- 装置のローカルクロックを参照クロックとして使用し、ネットワーク内の他の装置を同期させます。

2.1.3. アソシエーションモード

NTP は以下のアソシエーションモードをサポートします。

- クライアント/サーバモード
- シンメトリックアクティブ/パッシブモード

表 2-1 NTP 接続モード

モード	動作プロセス	原則	アプリケーションシナリオ
クライアント/サーバ	クライアント側で、NTPサーバのIPアドレスを指定します。 クライアントはNTPサーバに時刻同期メッセージを送信します。メッセージを受信すると、サーバは自動的にサーバモードで動作し、応答を送信します。 クライアントが複数の時刻サーバに同期できる場合、サーバからの応答を受信した後、最適な時刻を選択し、ローカルクロックを最適な参照ソースに同期させます。	クライアントはサーバに同期できますが、サーバはクライアントに同期できません。	図 2-2 が示すように、このモードは上位stratumの装置が下位stratumの装置に同期する構成を想定しています。
シンメトリックアクティブ/パッシブ	シンメトリックアクティブ側では、シンメトリックパッシブ側のIPアドレスを指定します。 シンメトリックアクティブピアは、シンメトリックパッシブピアに定期的にクロック同期メッセージを送信します。シンメトリックパッシブピアは自動的にシンメトリックパッシブモードで動作し、応答を送信します。 シンメトリックアクティブピアが複数の時刻サーバに同期できる場合、サーバからの応答を受信した後、最適なクロックを選択し、ローカルクロックを最適な参照ソースに同期させます。	シンメトリックアクティブピアとシンメトリックパッシブピアは相互に同期可能です。両者が同期する場合、stratum値の高いピアが低いピアに同期します。	図 2-2 に示すように、このモードは主に同じstratumを持つサーバ間で相互のバックアップとして運用されます。あるサーバが下位stratumの全サーバとの通信に失敗した場合でも、同stratumのサーバには同期を維持できます。

この文書において、「NTP サーバ」または「サーバ」とは、クライアント/サーバモードで NTP サーバとして動作する装置を指します。タイムサーバとは、NTP サーバおよび NTP シンメトリックピアを含む、時刻同期を提供できるすべての装置を指します。

2.1.4. NTP セキュリティ

時刻同期のセキュリティを強化するため、NTP はアクセス制御と認証機能を提供します。

I. NTP アクセス制御

ACL を使用して NTP アクセスを制御できます。アクセス権限は以下の通りです。

- **ignore** - NTP 制御クエリを含む全てのパケットを拒否します。
- **nomodify** - サーバの状態を変更しようとする NTP 制御クエリ（実行時再構成）を拒否します。情報のみを返すクエリは許可されます。

- **noquery** - すべての NTP 制御クエリを拒否します。
- **nopeer** - 認証されていない場合、アソシエーションを動員する可能性のあるパケットを拒否する。これにはブロードキャスト、シンメトリックアクティブ、および設定済みのアソシエーションが存在しない場合のマルチキャストサーバパケットが含まれます。このフラグは、アソシエーションの動員を試みないパケットには適用されません。
- **noserve** - NTP 制御クエリを除く全てのパケットを拒否します。
- **notrust** - 暗号的に認証されていないパケットを拒否します。認証が有効な場合（デフォルト）、アソシエーションを起動する可能性のある全てのパケットは認証を必要とします。

  認証が無効化されているが本フラグが存在しない場合、認証なしでもアソシエーションを起動できます。認証が無効化され本フラグが存在する場合、指定されたアドレス/マスク範囲に対してのみ認証が要求されます。
- **version** - 現在の NTP バージョンと一致しないパケットを拒否します。

この機能は、NTP を実行するシステムに最小限のセキュリティを提供します。より安全な方法は NTP 認証です。

II. NTP 認証

セキュリティ目的で NTP メッセージを認証するためにこの機能を使用します。NTP メッセージが認証を通過した場合、装置はそれを受信し時刻同期情報を取得できます。通過しない場合、装置はメッセージを破棄します。この機能により、装置が不正な時刻サーバに同期しないことが保証されます。

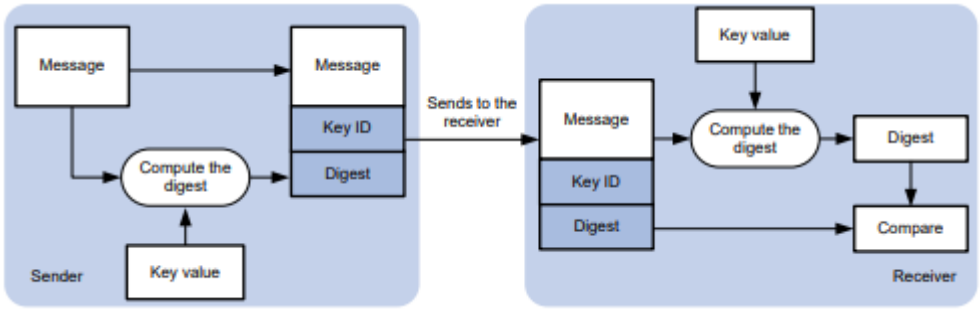

図 2-3 NTP 認証

図 2-3 に示すように、NTP 認証は以下のように動作します。

1. 送信者は、キーID で識別されるキーを使用して、指定された認証アルゴリズムを通じて NTP メッセージのダイジェストを計算します。その後、計算されたダイジェストを NTP メッセージおよびキーID と共に受信者に送信します。
2. メッセージを受信すると、受信側は以下の処理を行います。
   a. メッセージ内のキーID に基づいてキーを検索します。
   b. キーと同一の認証アルゴリズムを用いてダイジェストを計算します。
   c. ダイジェストを NTP メッセージに含まれるダイジェストと比較します。
      – 異なる場合、受信側はメッセージを破棄します。

- 一致し、かつ NTP セッションの作成が不要な場合、受信側はメッセージに応答します。NTP セッションの詳細については、「2.8.2. 最大アソシエーション数の設定」を参照してください。
- それらが同一であり、NTP セッションが作成されるか、または作成済みの場合、ローカル装置は送信者が認証 ID の使用を許可されているかどうかを判断します。送信者が認証 ID の使用を許可されている場合、受信者はメッセージを受け入れます。送信者が認証 ID の使用を許可されていない場合、受信者はメッセージを破棄します。

2.1.5. プロトコルと標準

- RFC 1305, *Network Time Protocol (Version 3) Specification, Implementation and Analysis*
- RFC 5905, *Network Time Protocol Version 4: Protocol and Algorithms Specification*

2.2. 制限事項とガイドライン

NTP を設定する際は、以下の制限事項とガイドラインに従ってください。

- NTP は以下のレイヤ 3 インタフェースでのみ設定できます。
  - VLAN インタフェース
- 頻繁な時刻変更や同期失敗を避けるため、ネットワーク上で複数の参照ソースを指定しないでください。

2.3. 設定作業リスト

作業リスト
(必須設定項目) NTPサービスの有効化
(必須設定項目) 以下のいずれか、または両方の作業を実行します。 • NTP アソシエーションモードの設定 • ローカルクロックを参照ソースとして設定
(オプション設定項目) アクセス制御権の設定
(オプション設定項目) NTP認証の設定
(オプション設定項目) NTPオプションパラメータの設定

2.4. NTPサービスの有効化

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NTP サービスを有効にする	**ntp-service enable**	デフォルト：無効

2.5. NTPアソシエーションモードの設定

このセクションでは、NTP アソシエーションモードの設定方法について説明します。

2.5.1. クライアント/サーバモードの NTP 設定

NTP クライアントを設定する際は、以下のガイドラインに従ってください。

- クライアントが NTP サーバと同期するには、サーバが他の装置によって同期されているか、ローカルクロックを参照ソースとして使用していることを確認してください。
- サーバの stratum レベルがクライアント以上である場合、クライアントはそのサーバに同期しません。
- **ntp-service unicast-server** コマンドを複数回実行することで、複数のサーバを設定できます。
- 装置がクライアント/サーバモードで動作する場合、クライアント上でサーバの IP アドレスを指定します。

NTP クライアントを設定するには:

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. 装置の NTP サーバを指定する	**ntp-service unicast-server** { *ip-address* | *ipv6-address* } [**version** *number*] [**key** *key-id*] [**prefer**] [**min-poll** *interval*] [**max-poll** *interval*]	デフォルト：指定なし

2.5.2. シンメトリックアクティブ/パッシブモードの NTP 設定

シンメトリックアクティブピアを設定する際は、以下のガイドラインに従ってください。

- シンメトリックパッシブピアがシンメトリックアクティブピアからの NTP メッセージを処理するには、シンメトリックパッシブピアで **ntp-service enable** コマンドを実行して NTP を有効化します。
- シンメトリックアクティブピアとシンメトリックパッシブピア間の時刻同期については、いずれか一方または両方が同期状態にあることを確認してください。
- **ntp-service unicast-peer** コマンドを複数回実行することで、複数のシンメトリックパッシブピアを設定できます。
- 装置がシンメトリックアクティブ/パッシブモードで動作する場合、シンメトリックアクティブピア上でシンメトリックパッシブピアの IP アドレスを指定します。

シンメトリックアクティブピアを設定するには：

操作	コマンド	補足
1. system view に移行する	**system-view**	―

操作	コマンド	補足
2. 装置にシンメトリックパッシブピアを指定する	**ntp-service unicast-peer** { *ip-address* | *ipv6-address* } [**version** *number*] [**key** *key-id*] [**prefer**] [**min-poll** *interval*] [**max-poll** *interval*]	デフォルト：指定なし

2.6. アクセス制御権の設定

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. ローカル装置上の NTP サービスへのアクセス権をピア装置に設定する	**ntp-service access-group** { **default** | *ip-address* [*ip-mask*] | *ipv6-address* | *ipv6-address/prefix-length* } [**ignore**] [**nomodify**] [**noquery**] [**nopeer**] [**noserve**] [**notrust**] [**version**]	デフォルト：ピア装置がローカル装置上のNTPサービスにアクセスする権限は**nomodify**および**noquery**です。

2.7. NTP認証の設定

このセクションでは、NTP 認証の設定手順について説明します。

2.7.1. クライアント/サーバモードの NTP 認証の設定

NTP 認証を確実に成功させるには、サーバとクライアントで同じ認証キーID、アルゴリズム、キーを設定してください。相手装置がローカル装置上のキーID を使用することを許可されていることを確認してください。

クライアントの NTP 認証を設定するには:

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NTP 認証を有効にする	**ntp-service authenticate**	デフォルト：有効
3. NTP 認証キーを設定する	**ntp-service authentication-key** *key-id* **md5** *value*	デフォルト：NTP認証キーは存在しません。
4. キーをトラステッドキーとして設定する	**ntp-service trusted-key** *key-id*	デフォルト：トラステッドキーとして設定された認証キーはありません。
5. 指定されたキーを NTP サーバに関連付ける	**ntp-service unicast-server** { *ip-address* | *ipv6-address* } [**key** *key-id*]	―

サーバの NTP 認証を設定するには:

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NTP 認証を有効にする	**ntp-service authenticate**	デフォルト：有効
3. NTP 認証キーを設定する	**ntp-service authentication-key** *key-id* **md5** *value*	デフォルト：NTP認証キーは設定されていません。
4. キーをトラステッドキーとして設定する	**ntp-service trusted-key** *key-id*	デフォルト：トラステッドキーとして設定された認証キーは存在しません。

クライアントとサーバで異なる設定を行うと、NTP 認証の結果が異なります。

表 2-2 NTP 認証の結果

クライアント			サーバ		認証結果
NTP 認証を有効にする	キーをトラステッドキーとして設定する	NTP サーバにキーを関連付ける	NTP 認証を有効にする	キーをトラステッドキーとして設定する	
Yes	Yes	Yes	Yes	Yes	成功
Yes	Yes	Yes	Yes	No	失敗
Yes	Yes	Yes	No	―	失敗
Yes	No	Yes	―	―	失敗
Yes	―	No	―	―	認証なし
No	―	―	―	―	認証なし

2.7.2. シンメトリックアクティブ/パッシブモードの NTP 認証の設定

NTP 認証を確実に成功させるには、アクティブピアとパッシブピアで同じ認証キーID、アルゴリズム、キーを設定してください。ピア装置がローカル装置でキーID を使用できることを確認してください。

アクティブピアの NTP 認証を設定するには：

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NTP 認証を有効にする	**ntp-service authenticate**	デフォルト：有効
3. NTP 認証キーを設定する	**ntp-service authentication-key** *key-id* **md5** *value*	デフォルト：NTP 認証キーは存在しません。

操作	コマンド	補足
4. キーをトラステッドキーとして設定する	**ntp-service trusted-key** *key-id*	デフォルト：トラステッドキーとして認証キーは設定されていません。
5. 指定したキーをパッシブピアに関連付ける	**ntp-service unicast-peer** { *ip-address* | *ipv6-address* } [**key** *key-id*]	―

パッシブピアの NTP 認証を設定するには:

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NTP 認証を有効にする	**ntp-service authenticate**	デフォルト：有効
3. NTP 認証キーを設定する	**ntp-service authentication-key** *key-id* **md5** *value*	デフォルト：NTP認証キーは設定されていません。
4. キーをトラステッドキーとして設定する	**ntp-service trusted-key** *key-id*	デフォルト：認証キーはトラステッドキーとして設定されていません。

アクティブピアとパッシブピアで異なる設定を行うと、NTP 認証の結果が異なります。

表 2-3 NTP 認証の結果

アクティブピア			パッシブピア		
NTP 認証を有効にする	キーをトラステッドキーとして設定する	パッシブピアにキーを関連付ける	NTP 認証を有効にする	キーをトラステッドキーとして設定する	認証結果
アクティブピアとパッシブピアのstratumレベルは考慮されません。					
Yes	Yes	Yes	Yes	Yes	成功
Yes	Yes	Yes	Yes	No	失敗
Yes	Yes	Yes	No	―	失敗
Yes	―	No	Yes	―	失敗
Yes	―	No	No	―	認証なし
No	―	―	Yes	―	失敗
No	―	―	No	―	認証なし
アクティブピアはパッシブピアよりも高いstratumを持ちます。					
Yes	No	Yes	―	―	失敗
パッシブピアはアクティブピアよりも高いstratumを持ちます。					
Yes	No	Yes	Yes	―	失敗
Yes	No	Yes	No	―	認証なし

2.8. NTPオプションパラメータの設定

このセクションの設定作業はオプションです。NTP のセキュリティ、パフォーマンス、信頼性を向上させるために設定してください。

2.8.1. NTP メッセージ受信のインタフェース無効化

NTP が有効な場合、デフォルトではすべてのインタフェースが NTP メッセージを受信できます。セキュリティ上の理由から、一部のインタフェースで NTP メッセージの受信を無効化できます。

インタフェースの NTP メッセージ受信を無効にするには:

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. interface view に移行する	**interface** *interface-type interface-number*	―
3. NTP メッセージを受信するインタフェースを無効にする	**ntp-service disable**	デフォルト : インタフェースはNTPメッセージを受信します。

2.8.2. 最大アソシエーション数の設定

NTP には以下のアソシエーションタイプがあります。

- **スタティックアソシエーション** – 手動で作成されたアソシエーションです。

各アソシエーションモードにおけるアソシエーションの確立方法を以下に説明します。

- **クライアント/サーバモード** – NTP サーバを指定すると、システムはクライアント側にスタティックアソシエーションを作成します。サーバはメッセージ受信時に受動的に応答するのみで、アソシエーション（スタティックまたはダイナミック）を作成しません。
- **シンメトリックアクティブ/パッシブモード** – シンメトリックアクティブピア上でシンメトリックパッシブピアを指定すると、シンメトリックアクティブピア上にスタティックアソシエーションが作成されます。

1 台の装置が同時に確立できるアソシエーションの最大数は 64 です。

アソシエーションがシステムリソースを過剰に占有するのを防ぐため、アソシエーション数を制限するにはこの作業を実行します。

アソシエーションの最大数を設定するには :

操作	コマンド	補足
4. system view に移行する	**system-view**	―
5. 確立を許可するセッションの最大数を設定する	**ntp-service max-associations** *number*	デフォルト : このコマンドは最大32セッションを確立できます。

2.9. ローカルクロックを基準ソースとして設定

ローカルクロックを基準ソースとして設定する際は、以下のガイドラインに従ってください。

- ローカルクロックが、ネットワークに必要な時刻精度を提供できることを確認してください。ローカルクロックを基準ソースとして設定すると、ローカルクロックは同期され、ネットワーク内の他のデバイスを同期させる NTP サーバとして機能するようになります。ローカルクロックの時刻が正しくない場合、タイミングエラーが発生します。
- この機能を設定する前に、ローカルシステム時刻を調整して、正確であることを確認してください。
- デバイスによってクロックの精度は異なります。ネットワークのフラッピングやクロック同期の失敗を防ぐため、同一のネットワークセグメント上で複数の基準ソースを設定しないでください。

ローカルクロックを基準ソースとして設定するには

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. ローカルクロックを基準ソースとして設定する	**ntp-service master** *stratum*	デフォルト : このデバイスはローカルクロックを基準ソースとして使用しません。

2.10. NTPの表示と維持

すべての view で **display** コマンドを実行できます。

操作	コマンド
NTPアソシエーションに関する情報を表示する	**display ntp-service associations** [**detail**]
NTPサービスのステータスに関する情報を表示する	**display ntp-service status**

2.11. NTP設定例

2.11.1. NTP クライアント/サーバモードの設定例

I. ネットワーク要件

図 2-4 に示すように、以下の作業を実行します。

- Device A のローカルクロックを stratum レベル 2 の参照ソースとして設定します。
- Device B をクライアントモードで動作させ、Device A を Device B の NTP サーバとして使用するように設定します。

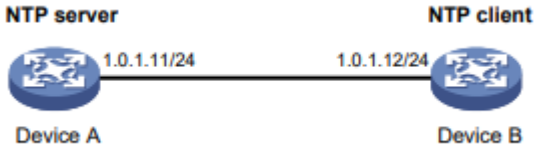

図 2-4 ネットワーク図

II. 設定手順

1. 各インタフェースに IP アドレスを割り当て、図 2-4 に示すように Device A と Device B が相互に到達できることを確認してください。(詳細は省略します)
2. Device A を設定します(詳細は省略します)。

ローカルクロックを参照ソースとして指定し、stratum レベルを 2 に設定します。(詳細は省略します)

3. Device B を設定します。

NTP サービスを有効化します。

```
<SwitchB> system-view
[SwitchB] ntp-service enable
```

Device B が Device A に同期されるよう、Device A を Device B の NTP サーバとして指定します。

```
[SwitchB] ntp-service unicast-server 1.0.1.11
[SwitchB] quit
```

4. 設定を確認します。

Device B が Device A に同期していること、および Device B のクロック stratum レベルが 3、Device A が 2 であることを確認します。

```
<SwitchB> display ntp-service status
Leap Indicator: Synchronized
Stratum: 3
Precision: -20
Root Distance: 0.00124 s
Root Dispersion: 0.00258 s
Reference ID: [1.0.1.11]
Reference Time: ec46cc0e.9ce1b62a [Wed, Aug 13 2025 17:32:14.612 UTC]
System Flags: Auth Monitor NTP Kernel Stats
Jitter: 0.000000 s
Stability: 0.000 ppm
Auth Delay: 0.000000 s
```

Device B と Device A の間に IPv4 NTP アソシエーションが確立されていることを確認します。

```
<SwitchB> display ntp-service associations
Remote Local St Poll Reach Delay Offset Disp
=============== =============== == ===== ===== ======= ========= =======
*1.0.1.11 1.0.1.12 2 64 377 0.00124 0.000042 0.04236
+ Symmetric active, - Symmetric passive, = Client, * System Peer
```

2.11.2. NTP シンメトリックアクティブ/パッシブモードの設定例

I. ネットワーク要件

図 2-5 に示すように、以下の作業を実行します。

- Device B のローカルクロックを、stratum レベル 2 の参照ソースとして設定します。
- Device B をシンメトリックアクティブモードで動作させ、Device B を Device A のパッシブピアとして指定します。

図 2-5 ネットワーク図

II. 設定手順

1. 各インタフェースに IP アドレスを割り当て、図 2-5 に示すように Device A と Device B が相互に到達できることを確認してください。(詳細は省略します)
2. Device B を設定します(詳細は省略します)。

ローカルクロックを参照ソースとして指定し、stratum レベルを 2 に設定します。

3. Device A を設定します。

NTP サービスを有効化します。

```
<SwitchA> system-view
[SwitchA] ntp-service enable
```

Device A をシンメトリックアクティブピアとして設定します。

```
[SwitchA] ntp-service unicast-peer 3.0.1.32
[SwitchA] quit
```

4. 設定を確認します。

Device A が Device B に同期していることを確認します。

```
<SwitchA> display ntp-service status
Leap Indicator: Synchronized
Stratum: 3
Precision: -20
Root Distance: 0.00128 s
Root Dispersion: 0.93881 s
Reference ID: [3.0.1.32]
Reference Time: ec46d8ea.c1914814 [Wed, Aug 13 2025 18:27:06.756 UTC]
System Flags: Auth Monitor NTP Kernel Stats
Jitter: 0.000000 s
```

```
Stability: 0.000 ppm
Auth Delay: 0.000000 s
```

Device B と Device A の間で IPv4 NTP 接続が確立されていることを確認します。

```
<SwitchA> display ntp-service associations
Remote Local St Poll Reach Delay Offset Disp
=============== =============== == ===== ===== ======= ========= =======
*3.0.1.32 3.0.1.31 2 64 17 0.00128 -0.000459 0.96858
+ Symmetric active, - Symmetric passive, = Client, * System Peer
```

2.11.3. 認証付き NTP クライアント/サーバモードの設定例

I. ネットワーク要件

図 2-6 に示すように、以下の作業を実行します。

- Device A のローカルクロックを参照ソースとして設定し、stratum レベルを 2 に設定します。
- Device B をクライアントモードで動作するように設定し、Device A を Device B の NTP サーバとして指定します。
- Device A と Device B の両方で NTP 認証を設定します。

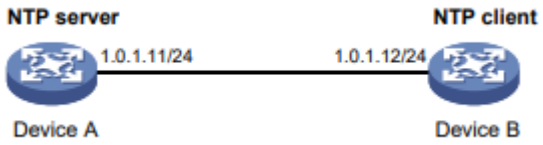

図 2-6 ネットワーク図

II. 設定手順

1. 各インタフェースに IP アドレスを割り当て、図 2-6 に示すように Device A と Device B が相互に到達できることを確認してください。(詳細は省略します)
2. Device A を設定します(詳細は省略します)。

   # ローカルクロックを参照ソースとして指定し、stratum レベルを 2 に設定します。

   # NTP 認証を有効にし、認証キーを設定しトラステッドキーとして指定します。

3. Device B を設定します。

   # NTP サービスを有効化します。

```
<SwitchB> system-view
[SwitchB] ntp-service enable
```

Device B で NTP 認証を有効にします。

```
[SwitchB] ntp-service authenticate
```

認証キーを設定し、平文でキーを入力します。

```
[SwitchB] ntp-service authentication-key 42 md5 aNiceKey
```

キーをトラステッドキーとして指定します。

```
[SwitchB] ntp-service trusted-key 42
```

Device B の NTP サーバとして Device A を指定し、サーバをキー42 に関連付けます。

```
[SwitchB] ntp-service unicast-server 1.0.1.11 key 42
[SwitchB] quit
```

Device B が Device A のクロックと同期する前に、Device A で NTP 認証を有効にします。

4. 設定を確認します。

Device B が Device A に同期していること、および Device B のクロック stratum レベルが 3、Device A が 2 であることを確認します。

```
<SwitchB> display ntp-service status
Leap Indicator: Synchronized
Stratum: 3
Precision: -20
Root Distance: 0.00127 s
Root Dispersion: 0.06396 s
Reference ID: [1.0.1.11]
Reference Time: ec46df10.883118c6 [Wed, Aug 13 2025 18:53:20.531 UTC]
System Flags: Auth Monitor NTP Kernel Stats
Jitter: 0.000000 s
Stability: 0.000 ppm
Auth Delay: 0.000000 s
```

Device B と Device A 間で IPv4 NTP 接続が確立されていることを確認します。

```
<SwitchB> display ntp-service associations
Remote Local St Poll Reach Delay Offset Disp
=============== =============== == ===== ===== ======= ========= =======
*1.0.1.11 1.0.1.12 2 64 177 0.00127 0.000043 0.25192
+ Symmetric active, - Symmetric passive, = Client, * System Peer
```

目次

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3章 Information Center

装置上の Information Center は、ネットワーク管理者がネットワークのパフォーマンスを監視し、ネットワークの問題をトラブルシューティングできるように、すべてのモジュールのログを分類および管理します。

3.1. 概要

Information Center は送信元モジュールが生成したログを受信し、ユーザ定義の出力ルールに従って異なる宛先にログを出力します。送信元モジュールに基づいてログを分類、フィルタリング、出力できます。サポートされている送信元モジュールを確認するには、**info-center discriminator ?** を使用してください。

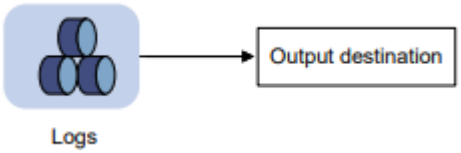

図 3-1 Information Center の図

デフォルトでは、Information Center は有効になっています。

3.1.1. ログレベル

ログは、0～7 までの 8 段階の重大度レベルに分類されます。（重大度が高い順）Information Center は、指定したレベル以上（0 以上）の重大度レベルを持つログを出力します。たとえば、重大度レベル 6（情報）を指定した場合、重大度レベル 0～6 までのログが出力されます。

表 3-1 ログレベル

重大度値	レベル	説明
0	Emergency	システムが使用不能です。例えば、システム認証の有効期限が切れているなどです。
1	Alert	直ちに対処が必要です。例えば、インタフェースのトラフィックが上限を超えた場合などです。
2	Critical	重大な状態です。例えば、装置の温度が上限を超えた、電源モジュールが故障した、ファントレイが故障したなどの場合です。
3	Error	エラー状態です。例えば、リンク状態が変化したなどの場合です。
4	Warning	警告状態です。例えば、インタフェースが切断された、またはメモリリソースが枯渇した場合などです。
5	Notification	正常だが重要な状態です。例えば、端末が装置にログインした、装置が再起動した場合などです。

重大度値	レベル	説明
6	Informational	情報メッセージです。例えば、コマンドやping操作が実行された場合などです。
7	Debugging	デバッグメッセージです。

3.1.2. ログの出力先

システムはコンソール、ログバッファ、ログホスト、ログファイルにログを出力します。ログ出力先は独立しており、Information Center を有効化した後に設定できます。1 つのログを複数の出力先に出力することも可能です。

3.1.3. ログのデフォルト出力ルール

ログ出力ルールは、宛先に出力可能なログの送信元モジュールと重大度レベルを指定します。出力ルールに一致するログは宛先に出力されます。表 3-2 にデフォルトのログ出力ルールを示します。

表 3-2 デフォルトの出力ルール

出力先	ログ送信元モジュール	出力装置	重要度
コンソール	サポートされるすべてのモジュール	有効	Informational
ログホスト	サポートされるすべてのモジュール	無効	Informational
ログバッファ	サポートされるすべてのモジュール	有効	Informational

3.2. Information Centerの設定作業リスト

作業リスト
以下の作業のうち少なくとも1つを実行してください。 • コンソールへのログ出力 • ログホストへのログ出力 • ログバッファへのログ出力

3.3. コンソールへのログ出力

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. Information Center を有効にする	**info-center on**	デフォルト：有効

操作	コマンド	補足
3. ローカルコンソールへのシステムメッセージのログ記録を有効にする	**info-center console** [**severity** { *severity-level* | *severity-name* }] [**discriminator** *name*]	デフォルト : 情報メッセージ（レベル 6）およびそれ以上の重大度のメッセージが送信されます。
4. さまざまな宛先に送信される SYSLOG メッセージをフィルタリングするために使用できる識別子を作成する	**info-center discriminator** *name* [**facility** { **drops** *string* | **includes** *string* }] [**severity** { **drops** *severity-list* | **includes** *severity-list* }]	デフォルト : 識別子は存在しません。
5. user view に戻る	**quit**	―

3.4. ログホストへのログ出力

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. Information Center を有効にする	**info-center on**	デフォルト : 有効
3. さまざまな宛先に送信される SYSLOG メッセージをフィルタリングするために使用できる識別子を作成する	**info-center discriminator** *name* [**facility** { **drops** *string* | **includes** *string* }] [**severity** { **drops** *severity-list* | **includes** *severity-list* }]	デフォルト : 識別子は存在しません。
4. システムメッセージやデバッグ出力を記録する SYSLOG サーバホストを作成する	**info-center server** { *ip-address* | *ipv6-address* } [**severity** { *severity-level* | *severity-name* }] [**discriminator** *name*] [**port** *udp-port*]	デフォルト : SYSLOGホストは設定されていません。

3.5. ログバッファへのログ出力

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. Information Center を有効にする	**info-center on**	デフォルト : 有効
3. ログバッファへのログ出力を有効にする	**info-center buffered**	デフォルト : ログバッファへのログ出力は有効です。
4. ローカルメッセージバッファへのシステムメッセージのログ記録を有効にする	**info-center buffered** [**severity** { *severity-level* | *severity-name* }] [**discriminator** *name*]	デフォルト : 情報レベル（レベル6）およびそれ以上の重大なメッセージが送信されます。

3.6. Information Centerの表示と維持

すべての view で **display** コマンドを実行でき、user view で **reset** コマンドを実行できます。

操作	コマンド
ログバッファの状態とログ情報を表示する	**display logbuffer**
ログバッファをクリアする	**reset logbuffer**

3.7. Information Centerの設定例

3.7.1. コンソールへのログ出力の設定例

I. ネットワーク要件

warning 以上の重大度レベルを持つ FTP ログをコンソールに出力するように Device を設定します。

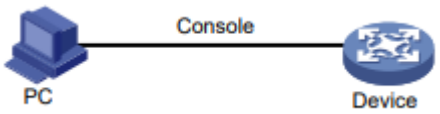

図 3-2 ネットワーク図

II. 設定手順

Information Center を有効にします。

```
<Switch> system-view
[Switch] info-center on
```

識別子を作成します。FIRMWARE の syslog 出力のみを許可します。

```
[Switch] info-center discriminator Test facility includes FIRMWARE severity includes
0,1,2,3,4,5,6,7
```

識別子をコンソールの FIRMWARE ログのうち、重大度が少なくとも informational レベル以上のログに設定します。コンソールは FIRMWARE ログのみを受信し、レベルは informational レベル以上である必要があります。

```
[Switch] info-center console severity informational discriminator Test
[Switch] info-center buffered severity informational discriminator Test
[Switch] quit
```

FTP 経由での FIRMWARE アップグレードはログを生成します。

```
<Switch> copy ftp: //1:1@192.168.1.33/QX-S900M-V1014.bin flash: QX-S900M-V1014.bin
Address of remote host [192.168.1.33]?
Source username [1]?
Source password [1]?
TCP port number of remote host [default]?
Source filename [QX-S900M-V1014.bin]?
```

```
Destination filename [QX-S900M-V1014.bin]?
Accessing ftp://192.168.1.33/QX-S900M-V1014.bin...
Transmission start...
Transmission finished, file length 48818812 bytes.
Please wait, programming flash.............. Done.
```

Information Center は自動的にログをコンソールに送信し、コンソールはログを表示します。

```
<Switch><190>1 2025-09-19T07:05:00.747114+09:00 QX-S916MT-4X-PW FIRMWARE 585 - -
Firmware upgraded
by aux0 successfully (Username: admin, Server IP: 192.168.1.33, File Name:
QX-S900M-V1014.bin)
```

3.7.2. UNIX ログホストへのログ出力の設定例

I. ネットワーク要件

informational 以上の重大度レベルを持つ FTP ログを UNIX ログホストに出力するように Device を設定します。

図 3-3 ネットワーク図

II. 設定手順

設定前に、Device とログホストが相互に到達可能であることを確認してください。（詳細は省略します）

1. ログホストを設定します。

   以下の設定は Solaris で行われました。他の UNIX オペレーティングシステムでも同様の設定が可能です。

   a. root ユーザとしてログホストにログインします。

   b. **/var/log/**ディレクトリ内に **Device** というサブディレクトリを作成し、**Device** ディレクトリ内に **Device** からのログを保存する **info.log** ファイルを作成します。

   ```
   # mkdir /var/log/Device
   # touch /var/log/Device/info.log
   ```

   c. **/etc/**ディレクトリ内の **syslog.conf** ファイルを編集し、以下の内容を追加します。

   ```
   # Device configuration messages
   *.info /var/log/Device/info.log
   ```

   この設定では、*はログホストがログを受信するために使用するすべてのログ機能を表します。info は情報レベルです。UNIX システムは、少なくとも informational レベルの重大度を持つログ情報を/var/log/Device/info.log ファイルに記録します。

> 🕮 メモ:
>
> **/etc/syslog.conf** ファイルを編集する際は、以下のガイドラインに従ってください。
>
> - コメントは別行に記載し、必ずシャープ記号（#）で始めてください。
> - ファイル名の後には余分なスペースを挿入しないでください。
> - **/etc/syslog.conf** ファイルで指定されるロギングファシリティ名と重大度レベルは、**info-center loghost** および **info-center source** コマンドを使用して Device 上で設定されたものと同一である必要があります。そうでない場合、ログ情報がログホストに正しく出力されない可能性があります。

d. syslogd のプロセス ID を表示し、syslog を再起動します。

```
# ps -ae | grep syslogd
147
#svcadm restart system/system-log
```

2. Device を設定します。

Information Center を有効化します。

```
<Switch> system-view
[Switch] info-center on
```

識別子を作成します。FIRMWARE の syslog 出力のみを許可します。

```
[Switch] info-center discriminator Test facility includes FIRMWARE severity includes
0,1,2,3,4,5,6,7
```

識別子をコンソールの FIRMWARE ログのうち、重大度が少なくとも informational レベル以上のログに設定します。コンソールは FIRMWARE ログのみを受信し、レベルは informational レベル以上である必要があります。

```
[Switch] info-center console severity informational discriminator Test
[Switch] info-center buffered severity informational discriminator Test
[Switch] quit
```

FTP 経由での FIRMWARE アップグレードはログを生成します。

```
<Switch> copy ftp: //1:1@192.168.1.33/QX-S900M-V1014.bin flash: QX-S900M-V1014.bin
Address of remote host [10.90.90.33]?
Source username [1]?
Source password [1]?
TCP port number of remote host [default]?
Source filename [QX-S900M-V1015.bin]?
Destination filename [QX-S900M-V1015.bin]?
Accessing ftp://10.90.90.33/QX-S900M-V1015.bin...
Transmission start...
Transmission finished, file length 48821456 bytes.
Please wait, programming flash.............. Done.
```

これで、Device は FTP ログをログホストに出力できるようになり、ログは指定されたファイルに保存されます。

3.7.3. Linux ログホストへのログ出力の設定例

I. ネットワーク要件

Device を少なくとも **informational** レベルの重大度を持つ FTP ログを Linux ログホスト 1.2.0.1/16 に出力するように設定します。

図 3-4 ネットワーク図

II. 設定手順

設定前に、Device とログホストが相互に到達可能であることを確認してください。（詳細は省略します）

1. ログホストを設定します。

Linux で rsyslog を再起動します。

```
#sudo service rsyslog restart
```

2. Device を設定します。

Information Center を有効化します。

```
<Switch> system-view
[Switch] info-center on
```

識別子を作成します。FIRMWARE の syslog 出力のみ許可します。

```
[Switch] info-center discriminator Test facility includes FIRMWARE severity includes
0,1,2,3,4,5,6,7
```

識別子をコンソールの FIRMWARE ログのうち、重大度が少なくとも informational レベル以上のログに設定します。コンソールは FIRMWARE ログのみを受信し、レベルは informational レベル以上である必要があります。

```
[Switch] info-center console severity informational discriminator Test
[Switch] info-center buffered severity informational discriminator Test
[Switch] quit
```

FTP 経由での FIRMWARE アップグレードはログを生成します。

```
<Switch> copy ftp: //1:1@192.168.1.33/QX-S900M-V1014.bin flash: QX-S900M-V1014.bin
Address of remote host [10.90.90.33]?
Source username [1]?
Source password [1]?
TCP port number of remote host [default]?
Source filename [QX-S900M-V1015.bin]?
Destination filename [QX-S900M-V1015.bin]?
Accessing ftp://10.90.90.33/QX-S900M-V1015.bin...
Transmission start...
Transmission finished, file length 48821456 bytes.
Please wait, programming flash.............. Done.
```

これで、システムは指定されたファイルにログ情報を記録できるようになりました。

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4章 SNMP

4.1. 概要

SNMP は、管理ステーションが、ベンダ、物理的特性、相互接続技術に関係なく、ネットワーク上の装置にアクセスし、操作するために広く使用されているインターネット標準プロトコルです。

SNMP により、ネットワーク管理者は、状態監視、トラブルシューティング、統計情報の収集、その他の管理目的のために、管理対象装置の変数を読み取り、設定することができます。

4.1.1. SNMP の構造

SNMP の構造には以下の要素が含まれます。

- **SNMP マネージャー**－ネットワーク管理システム(NMS)上で動作し、ネットワーク内の SNMP 対応装置を監視および管理します。
- **SNMP エージェント**－管理対象装置上で動作し、NMS からの要求を受信・処理するとともに、インタフェース状態の変化などのイベント発生時に NMS へ通知を送信します。
- **管理情報ベース（MIB）**－SNMP マネージャーが読み取りおよび設定するために、SNMP エージェントが維持する変数（例：インタフェース状態、CPU 使用率）を規定します。

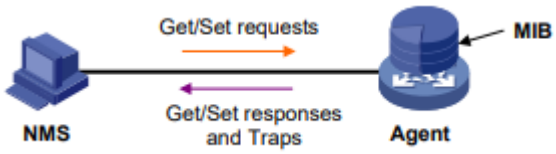

図 4-1 NMS、エージェント、MIB の関係

4.1.2. MIB および view ベースの MIB アクセス制御

MIB は「ノード」または「オブジェクト」と呼ばれる変数をツリー階層構造で格納し、各ノードを一意の OID で識別します。OID はドット区切り数値列であり、ルートノードからリーフノードまでのパスを一意に識別します。例えば、図 4-2 のオブジェクト B は OID{1.2.1.1}によって一意に識別されます。

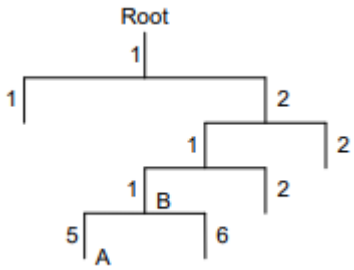

図 4-2 MIB ツリー

MIB view は、特定のアクセス権限を持つ MIB オブジェクト（または MIB オブジェクト階層）の集合を表し、view 名によって識別されます。MIB view に含まれる MIB オブジェクトはアクセス可能ですが、MIB view から除外された MIB オブジェクトはアクセス不可です。

MIB view は、view 名と OID ツリーのペアで識別される複数の view レコードを持つことができます。SNMP グループまたはコミュニティに MIB view を割り当てることで、MIB へのアクセスを制御します。

4.1.3. SNMP 操作

SNMP は以下の基本操作を提供します。

- **Get** – NMS がエージェント MIB 内の SNMP オブジェクトノードを取得します。
- **Set** – NMS がエージェント MIB 内のオブジェクトノードの値を変更します。
- **Notification** – SNMP エージェントが trap または inform を送信し、イベントを NMS に報告します。これら 2 種類の通知の違いは、inform は応答を必要とするが trap は不要である点です。trap は SNMPv1、SNMPv2c、SNMPv3 で利用可能ですが、inform は SNMPv2c と SNMPv3 でのみ利用可能です。

4.1.4. プロトコルバージョン

NEC は SNMPv1、SNMPv2c、および SNMPv3 をサポートします。NMS と SNMP エージェントは、相互通信のために同一の SNMP バージョンを使用する必要があります。

- **SNMPv1** – 認証にコミュニティ名を使用します。SNMP エージェントにアクセスするには、NMS は SNMP エージェントに設定されたコミュニティ名と同じものを使用する必要があります。NMS が使用するコミュニティ名がエージェントに設定されたコミュニティ名と異なる場合、NMS はエージェントへのアクセスやエージェントからの trap 受信のための SNMP セッションを確立できません。
- **SNMPv2c** – 認証にコミュニティ名を使用します。SNMPv2c は SNMPv1 と互換性がありますが、より多くの操作タイプ、データタイプ、およびエラーコードをサポートします。
- **SNMPv3** – ユーザベースのセキュリティモデル（USM）を使用して SNMP 通信を保護します。認証とプライバシーのメカニズムを設定し、SNMP パケットの完全性、真正性、機密性を確保するために認証と暗号化を行うことができます。

4.1.5. アクセス制御モード

SNMP は MIB オブジェクトへのアクセス制御に以下のモードを使用します。

- **View-based Access Control Model** – VACM モードは、SNMP コミュニティまたはユーザに MIB view を割り当てることで MIB オブジェクトへのアクセスを制御します。
- **Role based access control** – RBAC モードは、SNMP コミュニティまたはユーザにユーザロールを割り当てることで MIB オブジェクトへのアクセスを制御します。
  - 事前定義されたユーザロール「admin」またはレベル 15 を持つ SNMP コミュニティまたはユーザは、すべての MIB オブジェクトに対する読み取りおよび書き込みアクセス権限を持ちます。
  - SNMP コミュニティまたは事前定義されたユーザロール「operator」を持つユーザは、すべての MIB オブジェクトに対して読み取り専用アクセス権を持ちます。
  - 事前定義されていないユーザロールを持つ SNMP コミュニティまたはユーザには、ユーザが割り当てたアクセス権限が適用されます。事前定義されていないユーザロールを作成するには、**role** コマンドを使用します。ユーザロールに MIB オブジェクトの権限を割り当てるには、**rule** コマンドを使用します。

RBAC モードは MIB オブジェクト単位でアクセスを制御し、VACM モードは MIB view 単位でアクセスを制御します。MIB セキュリティを強化するベストプラクティスとして、RBAC モードを使用してください。

両方のモードで同じ SNMP コミュニティまたはユーザを複数回作成した場合、最新の設定が有効になります。

4.2. SNMP基本パラメータの設定

SNMPv3 は SNMPv1 および SNMPv2c とは多くの点で異なります。それらの設定手順は別々のセクションで説明されています。

4.2.1. SNMPv1 または SNMPv2c の基本パラメータの設定

管理者またはレベル 15 のユーザロールを持つユーザのみが、SNMPv1 または SNMPv2c のコミュニティ、ユーザ、グループを作成できます。他のユーザロールを持つユーザは、関連するコマンドや SNMPv1/SNMPv2c 機能のコマンドへのアクセス権が付与されていても、SNMPv1 または SNMPv2c のコミュニティ、ユーザ、グループを作成できません。

SNMPv1 または SNMPv2c の基本パラメータを設定するには:

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. (オプション設定項目) SNMP エージェントを有効にする	**snmp-agent**	デフォルト：無効 SNMPエージェントは、**snmp-agent calculate-password**コマンドを除く、**snmp-agent**で始まるコマンドを使用すると有効になります。
3. (オプション設定項目) システム連絡先を設定する	**snmp-agent contact** *sys-contact*	デフォルト：システム連絡先は存在しません

操作	コマンド	補足
4. (オプション設定項目) システムロケーションを設定する	**snmp-agent location** *sys-location*	デフォルト : システムロケーションは存在しません。
5. (オプション設定項目) ローカルエンジン ID を設定する	**snmp-agent** *engineid*	デフォルト : ローカルエンジンIDは会社IDと装置IDの組み合わせです。装置IDは装置モデルによって異なります。
6. SNMP アクセスのコミュニティ文字列を設定する	**snmp-agent community** *community-string* [**view** *view-name*] [**read** | **write**] [*access ip-acl-name*]	―

4.2.2. SNMPv3 基本パラメータの設定

管理者またはレベル 15 のユーザロールを持つユーザのみが SNMPv3 ユーザまたはグループを作成できます。他のユーザロールを持つユーザは、関連するコマンドや SNMPv3 機能のコマンドへのアクセス権が付与されていても、SNMPv3 ユーザまたはグループを作成できません。

SNMPv3 ユーザはグループ単位で管理されます。グループ内の全 SNMPv3 ユーザは同一のセキュリティモデルを共有しますが、異なる認証およびプライバシーキー設定を使用できます。ユーザに対するセキュリティモデルを実装し SNMP 通信の失敗を回避するには、グループのセキュリティモデル設定とユーザのセキュリティキー設定が表 4-1 に準拠し、NMS の設定と一致していることを確認してください。

表 4-1 異なるセキュリティモデルの基本セキュリティの設定要件

セキュリティモデル	グループのセキュリティモデルキーワード	ユーザのセキュリティキー設定	補足
プライバシー保護による認証	**privacy**	認証キー、 プライバシーキー	認証キーまたはプライバシーキーが設定されていない場合、SNMP通信は失敗します。
プライバシーなしの認証	**authentication**	認証キー	認証キーが設定されていない場合、SNMP通信は失敗します。 ユーザのプライバシーキー（設定されている場合）は有効になりません。
認証なし、プライバシーなし	**authentication** **privacy**	なし	設定されている場合、認証キーとプライバシーキーは有効になりません。

SNMPv3 基本パラメータの設定方法:

操作	コマンド	補足
1. system view に移行する	**system-view**	―

操作	コマンド	補足
2. (オプション設定項目) SNMP エージェントを有効にする	**snmp-agent**	デフォルト：無効 SNMPエージェントは、**snmp-agent calculate-password**コマンドを除く、**snmp-agent**で始まるコマンドを使用すると有効になります。
3. (オプション設定項目) システム連絡先を設定する	**snmp-agent contact** *sys-contact*	デフォルト: システム連絡先は存在しません。
4. (オプション設定項目) システムロケーションを設定する	**snmp-agent location** *sys-location*	デフォルト: システムロケーションは存在しません。
5. (オプション設定項目) ローカルエンジン ID を設定する	**snmp-agent** *engineid*	デフォルト: ローカルエンジンIDは会社IDと装置IDの組み合わせです。装置IDは装置モデルによって異なります。 ⚠ 重要 ： ローカルエンジン ID を変更すると、既存の SNMPv3 ユーザと暗号化キーは無効になり、再設定が必要です。
6. SNMPv3 ユーザを作成する	**snmp-agent user** *user-name group-name* [**encrypted**] [**auth** { **md5** | **sha** } *auth-password* [**priv** { **des** *priv-password* | **aes** *priv-password* }] [**access** *ip-acl-name*]	**cipher**キーワードが指定された場合、*auth-password* および*priv-password* は暗号化キーとして使用されます。

4.3. SNMPログの設定

SNMP ログ記録は必要な場合のみ有効にしてください。SNMP ログ記録はメモリを大量に消費し、装置のパフォーマンスに影響を与える可能性があります。

SNMP エージェントは、Get リクエスト、Set リクエスト、Set 応答、SNMP 通知、および SNMP 認証失敗をログに記録しますが、Get 応答は記録しません。

- **Get 操作** – エージェントは、NMS の IP アドレス、アクセスされたノードの名前、およびノード OID をログに記録します。
- **Set 操作** – エージェントは、NMS の IP アドレス、アクセスされたノード名、ノード OID、変数値、および Set 操作のエラーコードとインデックスをログに記録します。
- **通知トラッキング** - エージェントは、SNMP 通知を NMS に送信した後、その通知をログに記録します。
- **SNMP 認証失敗** – エージェントは、NMS がエージェントによる認証に失敗した場合に関連情報をログに記録します。

SNMP モジュールはこれらのログを Information Center に送信します。Information Center は、コンソールやログバッファなどの特定の宛先にこれらのメッセージを出力するよう設定できます。各

ログエントリにおけるノードフィールド（MIB ノード名）と値フィールド（MIB ノードの値）の合計出力サイズは 1024 バイトです。この制限を超えると、Information Center はフィールド内のデータを切り捨てます。

4.4. SNMP通知の設定

SNMP エージェントは、リンク状態の変化やユーザのログイン/ログアウトなどの重要なイベントを NMS に通知するため、通知（trap と inform）を送信します。特に明記されていない限り、コマンドラインの における **trap** キーワードは trap と inform の両方を指します。

4.4.1. SNMP 通知の有効化

SNMP 通知は必要な場合のみ有効にしてください。SNMP 通知はメモリを大量に消費し、装置のパフォーマンスに影響を与える可能性があります。

モジュール通知を有効にした後、モジュールが通知を生成するかどうかは、モジュールの設定にも依存します。

SNMP 通知を有効にするには:

操作	コマンド	補足
1. system viewに移行する	**system-view**	―
2. SNMP 通知を有効にする	**snmp-agent trap enable**	デフォルト : 各モジュールのデフォルトはコマンドマニュアルを参照ください。
3. interface view に移行する	**interface** *interface-type interface-number*	―
4. リンク状態通知を有効にする	**snmp trap link-status**	デフォルト : リンク状態通知は有効です。

4.5. SNMP設定の表示

すべての view で **display** コマンドを実行できます。

操作	コマンド
SNMP設定を表示する	**display snmp-agent** { **community** | **target-host** | **view** | **group** | **engineID** | **traps** }
SNMPサーバのグローバル状態設定を表示する	**display snmp-agent sys-info**
ポートごとのSNMP trap送信状態を表示する	**display snmp-agent trap-sending** [**interface** *interface-id* [, | -]]
設定済みのSNMPユーザに関する情報を表示する	**display snmp-agent user** [*user-name*]
インタフェースごとのリンクステータスtrap状態を表示する	**display snmp trap link-status** [**interface** *interface-list*]
設定済みのSNMPユーザに関する情報を表示する	**display snmp-agent user** [*user-name*]

4.6. SNMPv1/SNMPv2c設定例

SNMPv1 の設定手順は SNMPv2c の設定手順と同じです。この例では SNMPv1 を使用します。

I. ネットワーク要件

図 4-3 に示すように、NMS(1.1.1.2/24)は SNMPv1 を使用して SNMP エージェント(1.1.1.1/24)を管理し、エージェントはイベントを報告する通知を NMS に自動的に送信します。

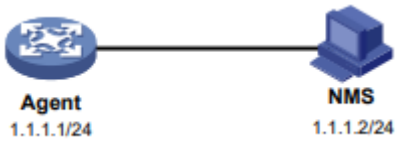

図 4-3 ネットワーク図

II. 設定手順

1. SNMP エージェントを設定します。

   # エージェントの IP アドレスを設定し、エージェントと NMS が相互に到達できることを確認します。(詳細は省略します)

   # 読み取り専用コミュニティ public と読み書き可能コミュニティ private を作成します。

```
<Switch> system-view
[Switch] snmp-agent
[Switch] snmp-agent community public read
[Switch] snmp-agent community private write
```

   # エージェントの連絡先および物理的な場所情報を設定します。

```
[Switch] snmp-agent contact Mr.Wang-Tel:3306
[Switch] snmp-agent location telephone-closet,3rd-floor
```

   # SNMP 通知を有効化し、SNMP trap 宛先として 1.1.1.2 の NMS を指定、コミュニティ名は **public** を使用します。（NMS が確実に trap を受信できるよう、**snmp-agent target-host** コマンドで NMS に設定済みの SNMP バージョンと同じバージョンを指定します。）

```
[Switch] snmp-agent trap enable
[Switch] snmp-agent trap enable snmp authentication
[Switch] snmp-agent target-host 1.1.1.2 version 1 public
```

2. SNMP NMS を設定します。
   - SNMPv1 を指定します。
   - 読み取り専用コミュニティ **public** と読み書き可能コミュニティ **private** を作成します。
   - 必要に応じてタイムアウトタイマと最大再試行回数を設定します。

III. 設定の確認

エージェントから NULL0 インタフェースの MTU 値の取得を試行します。試行は成功します。

```
Send request to 1.1.1.1/161 ...
Protocol version: SNMPv1
Operation: Get
Request binding:
1: 1.3.6.1.2.1.2.2.1.4.135471
Response binding:
1: Oid=ifMtu.135471 Syntax=INT Value=1500
Get finished
```

エージェント上の MIB ノードの値を取得するために不正なコミュニティ名を使用します。NMS 上で認証失敗 trap を確認できます。

```
1.1.1.1/2934 V1 Trap = authenticationFailure
SNMP Version = V1
Community = public
Command = Trap
Enterprise = 1.3.6.1.4.1.43.1.16.4.3.50
GenericID = 4
SpecificID = 0
Time Stamp = 8:35:25.68
```

4.7. SNMPv3設定例

I. ネットワーク要件

図 4-4 に示すように、NMS（1.1.1.2/24）は SNMPv3 を使用してエージェント（1.1.1.1/24）のインタフェース状態を監視および管理します。エージェントは自動的に通知を送信し、イベントを NMS に報告します。SNMP 通知にはデフォルトの UDP ポート 162 が使用されます。

NMS とエージェントは SNMP セッション確立時に認証を行います。認証アルゴリズムは SHA-1、認証キーは **123456TESTauth&!**です。NMS とエージェントはまた、AES アルゴリズムとプライバシーキー**123456TESTencr&!**を使用して相互間の SNMP パケットを暗号化します。

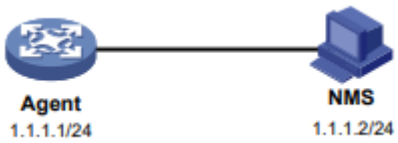

図 4-4 ネットワーク図

II. 設定手順

1. エージェントを設定します。

   # エージェントに IP アドレス 1.1.1.1/24 を割り当て、エージェントと NMS が相互に到達できることを確認します。(詳細は省略します)

   # user view test1、test2、test3 を作成し、test1 に **snmpMIB** ノード（OID:1.3.6.1.6.3.1）下のオブジェクト（linkUp および linkDown オブジェクトを含む）への読み取り専用アクセス権を割り当てます。

```
<Switch> system-view
[Switch] snmp-agent view test1 1.3.6.1.6.3.1 included
[Switch] snmp-agent view test2 1.3.6.1.2.1.1 included
[Switch] snmp-agent view test3 1.3.6.1.2.1.2 included
[Switch] snmp-agent group test1 v3 priv read test1 notify test1
```

システムノード（OID: 1.3.6.1.2.1.1）に対して view test2 の読み取り専用アクセスを割り当て、**interfaces** ノード（OID: 1.3.6.1.2.1.2）に対して view test3 の読み書きアクセスを割り当てます。

```
[Switch] snmp-agent group test2 v3 priv read test2 notify test2
[Switch] snmp-agent group test3 v3 priv read test3 write test3 notify test3
```

SNMPv3 ユーザ RBACtest1、RBACtest2、および RBACtest3 を作成します。ユーザロール test1 を RBACtest1 に、test2 を RBACtest2 に、test3 を RBACtest3 に割り当てます。認証アルゴリズムを SHA、認証キーを 123456TESTauth&!、暗号化アルゴリズムを DES、プライバシーキーを 123456TESTencr&!に設定します。

```
[Switch] snmp-agent user RBACtest1 test1 auth sha 123456TESTauth& priv
123456TESTauth&!
[Switch] snmp-agent user RBACtest2 test2 auth sha 123456TESTauth& priv
123456TESTauth&!
[Switch] snmp-agent user RBACtest3 test3 auth sha 123456TESTauth& priv
123456TESTauth&!
```

エージェントの連絡先および物理的な位置情報を設定します。

```
[Switch] snmp-agent contact Mr.Wang-Tel:3306
[Switch] snmp-agent location telgphone-closet,3rd-floor
```

エージェントで通知を有効化します。通知先として NMS を 1.1.1.2、ユーザ名として **RBACtest** を指定します。

```
[Switch] snmp-agent trap enable snmp linkdown
[Switch] snmp-agent trap enable snmp linkup
[Switch] snmp-agent trap enable snmp authentication
[Switch] snmp-agent target-host 1.1.1.2 version 3 priv RBACtest1
```

2. NMS を設定します。
   - SNMPv3 を指定します。
   - SNMPv3 ユーザ **RBACtest** を作成します。
   - 認証機能とプライバシー機能の両方を有効にします。
   - 認証には SHA-1 を、暗号化には AES を使用します。
   - 認証キーを **123456TESTauth&!**に設定し、プライバシーキーを **123456TESTencr&!**に設定します。
   - タイムアウトタイマと最大再試行回数を設定します。

NMS の設定については、NMS マニュアルを参照してください。

📖 メモ ：

エージェントと NMS の SNMP 設定は一致している必要があります。

III. 設定の確認

- ユーザ名 **RBACtest1** を使用してエージェントにアクセスします。

sysName ノードの値を取得します。値「**Agent**」が返されます。

sysName ノードの値を Sysname に設定します。NMS がノードへの書き込みアクセス権を持たないため、操作は失敗します。

エージェント上でインタフェースをシャットダウンまたは起動します。NMS は linkUp（OID: 1.3.6.1.6.3.1.1.5.4）または linkDown（OID:1.3.6.1.6.3.1.1.5.3）通知を受信します。

- ユーザ名 RBACtest2 を使用して、エージェントにアクセスします。

  # **sysName** ノードの値を取得します。値「**Agent**」が返されます。

  # **sysName** ノードの値を **Sysname** に設定します。操作は成功します。

  # エージェント上のインタフェースをシャットダウンまたは起動します。NMS は linkUp（OID: 1.3.6.1.6.3.1.1.5.4）または linkDown（OID:1.3.6.1.6.3.1.1.5.3）通知を受信します。

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5章 PoE

5.1. 概要

Power over Ethernet（PoE）は、ネットワーク機器がツイストペアケーブルを介して端末に電力を供給することを可能にします。この機器は IEEE 802.3af/at/at 規格をサポートしています。

図 5-1 に示すように、PoE システムは以下の要素で構成されます。

- **PoE power supply**：PoE システム全体に電力を供給します。
- **PSE**：電源供給装置（PSE）は、給電対象装置（PD）を検出して分類し、それらに電力を供給するとともに、電力および接続状態を監視します。PSE にはエンドポイント型とミッドスパン型があります。本装置における PSE はエンドポイント型です。複数の PSE を備えた装置では、PSE ID で識別します。**display poe device** コマンドは、PSE ID と PSE が接続されているスロットまたはサブスロット間のマッピングを表示します。
- **PI**：電力インタフェース（PI）は、PSE 上の PoE 対応 Ethernet インタフェースです。
- **PD**：給電対象装置（PD）は PSE から電力を受け取ります。PD には IP 電話、アクセスポイント、ポータブル充電器、POS 端末、ウェブカメラなどがあります。信頼性向上のため、PD を冗長電源に接続することも可能です。

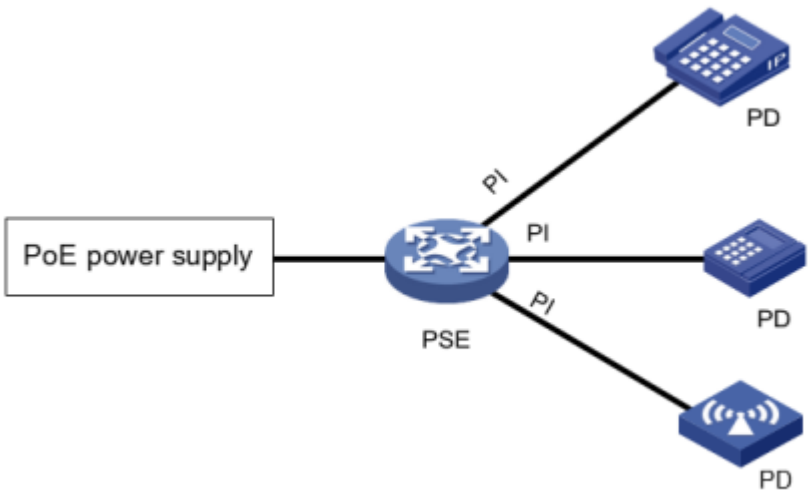

図 5-1 PoE システム図

5.2. PoE設定作業リスト

ポート上で直接 PI を設定するか、PoE プロファイルを作成して PI に適用することができます。単一の PI にはポート設定を使用し、複数の PI を一括設定する必要がある場合は PoE プロファイルを使用してください。

PoE 設定前に、PoE 電源装置と PSE が正常に動作していることを確認してください。動作していない場合、PoE 設定が不可能または設定が反映されません。

PoE を設定するには、以下の作業を実行します。

作業リスト
(必須設定項目) PIのPoE有効化
(オプション設定項目) PIの最大電力設定
(オプション設定項目) PI電力管理の設定
(オプション設定項目) PSE電力監視の設定

5.3. PIのPoE有効化

システムは、PoE 対応 PI に接続された PD に対してのみ電力を供給および確保します。

PSE の電力過負荷を引き起こさない限り、PI に対して PoE を有効化できます。過負荷は、すべての PI の合計消費電力が PSE の最大電力（設定可能）を超える場合に発生します。

PI で PoE を有効化すると PSE が過負荷になる場合､PI の電源管理が有効な時のみ有効化できます。詳細は「5.5. PI 電力管理の設定」を参照してください。

PSE は、PI に接続されたカテゴリ 3 またはカテゴリ 5 のツイストペアケーブルを介して、以下のモードで電力を供給します。

- **Signal モード**：データペア（ピン 1、2、3、6）を使用して直流電力を供給します。
- **Spare モード**：スペアペア（ピン 4、5、7、8）を使用して直流電力を供給します。

📖 メモ ：

- 本装置は Signal モードでのみ電力伝送をサポートします。
- PSE が PD に直接電力を供給できるのは、両者が同一の伝送モードを使用する場合のみです。モードが異なる場合、PD への電力供給にはツイストペアケーブルの配線順序を変更する必要があります。

以下に PI で PoE を有効にする設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. PI view に移行する	**interface** *interface-type interface-number*	―
3. PI の PoE を有効にする	**poe enable**	デフォルト：有効
4. （オプション設定項目）接続された PD の説明を設定する	**poe pd description** *text*	デフォルト : 説明は設定されていません。

5.4. PIの最大電力設定

PI の最大電力は、PI が接続された PD に供給できる最大電力です。PD がこの制限を超える電力を必要とする場合、PI は電力を供給しません。

以下に PI の最大電力を指定する設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. PI view に移行する	**interface** *interface-type interface-number*	―
3. （オプション設定項目）PI の最大電力を設定する	**poe power-inline max** *max-power*	デフォルト：PIの最大電力は30000ミリワットです。

5.5. PI電力管理の設定

PI 電力管理により、PSE 電力過負荷発生時に PSE は優先度に基づいて PI 電力を管理できます。PI 優先度レベルは重要度順に、critical、high、low です。PD は接続先の PI の優先度を継承します。全ての PSE は同一の PI 電力管理メカニズムを使用します。

I. PI の電力管理が無効の場合

PSE は最大 PSE 電力の設定有無に基づき過負荷状態に対応します。

最大 PSE 電力	PSE 動作
設定済み	PSEは新規PDへの電力供給を停止します。
設定なし	PoE自己保護メカニズムが作動すると、PSEは全てのPDへの電力供給を停止します。

II. PI の電力管理が有効な場合

PSE は過負荷を引き起こす既存の PD への電源供給を停止するか、過負荷を引き起こす可能性のある新規 PD に対して優先度に基づく処理を適用します。

新規 PD の優先度	PSE の動作
low	PSEは新しいPDに電力を供給しません。
high	• 優先度の低い PD が存在する場合、PSE はそれらへの電力供給を停止し、新しい PD に電力を供給します。 • 優先度の低い PD が存在しない場合、PSE は新しい PD に電力を供給しません。
critical	• 優先度の低い PD または優先度の高い PD が存在する場合は、PSE はそれらの PD への電力供給を停止し、新しい PD に電力を供給します。 • 低優先度または高優先度の PD が存在しない場合、PSE は新しい PD に電力を供給しません。

メモ ：

電力があらかじめ予約されている PI への設定は変更ありません。

III. 制限とガイドライン

- 複数の新規 PD が電力を要求した場合、PSE は優先度が高い順に電力を供給します。優先度が同じ PD については、PD ID が小さい方が優先されます。

- 複数の既存 PD を切断する必要がある場合、PSE は優先度の上昇順に電源供給を停止します。同一優先度の PD については、ID が最も大きい PD から先に切断されます。
- PSE は保証された PSE 電力を確保することで、重要 PI への無停電供給を保証します。PI への無停電供給を保証するには、その PI に重要優先度を割り当ててください。それ以外の場合は、高優先度または低優先度を使用して、利用可能な電力を PI 間でバランスよく配分します。
- PI に critical 優先度を割り当てる前に、残りの保証電力が PI の最大電力以上であることを確認してください。残りの保証 PSE 電力とは、最大 PSE 電力から、PoE 有効および PoE 無効の critical PI に割り当てられた最大電力を差し引いた値です。
- PD が PI に接続されたとき、PI は PSE の余力電力が PD が要求する電力とガードバンドの合計よりも大きい場合にのみ PD に電力を供給します。QX-S900M シリーズのガードバンド値は PD のクラスに関係なく 10W です。

以下に PI の電力管理を指定する設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. PI 電力管理を有効にする	**poe policy preempt**	デフォルト：無効
3. PI view に移行する	**interface** *interface-type interface-number*	―
4. （オプション設定項目）PI 電力の優先度を設定する	**poe pd priority** { **critical** | **high** | **low** }	デフォルト：low

5.6. PSE電力監視の設定

システムは PSE の電力使用率を監視し、設定されたしきい値を超過または下回った場合に通知メッセージを送信します。PSE の電力使用率が連続して複数回しきい値を超えた場合、システムは最初の超過時のみ通知を送信します。

以下に PSE 電力アラームしきい値を指定する設定を示します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. PSE 電力アラームしきい値を設定する	**poe usage-threshold** *value*	デフォルト：80%

5.7. PoEの表示と維持

すべての view で **display** コマンドを実行することができます。

操作	コマンド
一般的なPSE情報を表示する	**display poe power module**
特定のPIの電力供給状態を表示する	**display poe power-inline** [*interface-type interface-number*] **status**

操作	コマンド
PIの電力設定を表示する	**display poe power-inline** [*interface-type interface-number*] **configuration**
PSEの詳細情報を表示する	**display poe power module detail**

5.8. PoE設定例

I. ネットワーク要件

図 5-2 に示すように、以下の要件を満たすように PoE を設定します。

- IP phone および AP への給電を可能にします。
- 過負荷時に IP phone が最初に電力供給を受けるようにします。
- AP B に最大 9000 ミリワットの電力を割り当てます。

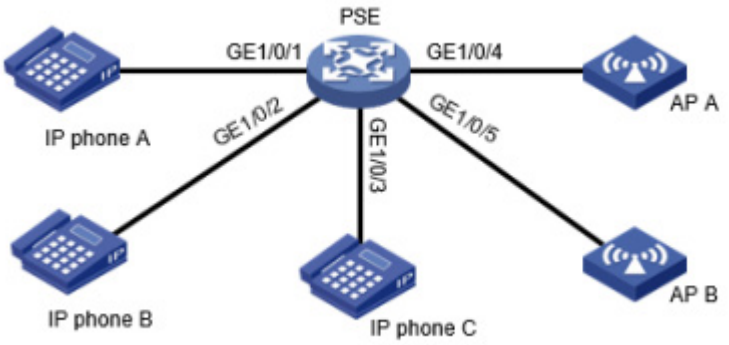

図 5-2 ネットワーク図

II. 設定手順

GigabitEthernet 1/0/1、1/0/2、および 1/0/3 で PoE を有効にし、それらの電力供給優先度を **critical** に設定します。

```
<PSE> system-view
[PSE] interface multi-GigabitEthernet 1/0/1
[PSE-GigabitEthernet1/0/1] poe enable
[PSE-GigabitEthernet1/0/1] poe pd priority critical
[PSE-GigabitEthernet1/0/1] quit
[PSE] interface multi-GigabitEthernet 1/0/2
[PSE-GigabitEthernet1/0/2] poe enable
[PSE-GigabitEthernet1/0/2] poe pd priority critical
[PSE-GigabitEthernet1/0/2] quit
[PSE] interface multi-GigabitEthernet 1/0/3
[PSE-GigabitEthernet1/0/3] poe enable
[PSE-GigabitEthernet1/0/3] poe pd priority critical
[PSE-GigabitEthernet1/0/3] quit
```

GigabitEthernet 1/0/4 および 1/0/5 で PoE を有効化し、GigabitEthernet 1/0/5 の最大電力を 9000 ミリワットに設定します。

```
[PSE] interface multi-GigabitEthernet 1/0/4
[PSE-GigabitEthernet1/0/4] poe enable
[PSE-GigabitEthernet1/0/4] quit
[PSE] interface multi-GigabitEthernet 1/0/5
[PSE-GigabitEthernet1/0/5] poe enable
[PSE-GigabitEthernet1/0/5] poe power-inline max 9000
```

III. 設定の確認

IP phone と AP を PSE に接続し、電力供給と正常動作を確認してください。（詳細は省略します）

5.9. PoEのトラブルシューティング

5.9.1. PI の優先度を critical に設定できない場合

I. 症状

PI の電源供給優先度設定が失敗します。

II. 解決策

問題を解決するには：

- PSE の残存保証電力が PI の最大電力を下回っているか確認します。該当する場合は、PSE の最大電力を増加させるか、PI の最大電力を減少させます。
- 別の方法で優先度が設定されていないか確認してください。設定されている場合は、既存の設定を削除してください。
- 問題が解決しない場合、販売店もしくは担当営業に問い合わせてください。

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6章 NetMeister

6.1 概要

NetMeister(ネットマイスター)は、NEC プラットフォームズが提供するクラウド型統合管理サービスです。NetMeister 対応のネットワーク機器をクラウド上で一元的に管理することができます。この章では、本装置を NetMeister に登録するための設定について説明します。

NetMeister の操作/詳細に関しては、NetMeister が提供する操作ガイドをご確認ください。
https://support.necplatforms.co.jp/netmeister/manual/

6.1.1 NetMeister の利用

NetMeister を利用する場合、あらかじめ NetMeister 上で「アカウント登録」と「グループ登録」が必要です。

QX シリーズは、NetMeister における親機モード、および、子機モードをサポートします。

親機モードでは、NetMeister と MQTT によって直接接続状態を確立し、NetMeister によって管理する事ができます。ただし、親機モードには、NetMeister Prime(有償サービス)の利用が必要です。NetMeister Prime については NetMeister が提供する操作ガイドをご確認ください。

子機モードでは、親機モードの装置と連携する事で NetMeister からの応答を受け、NetMeister によって管理する事ができます。図 6-1 に示すように、子機モードだけでは NetMeister を利用できません。

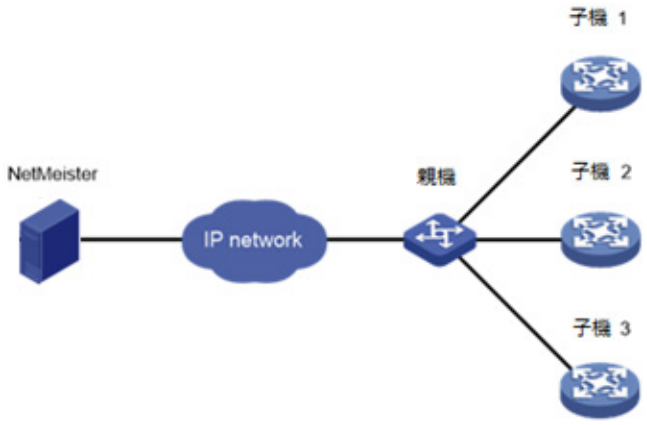

図 6-1 NetMeister との接続イメージ

子機モードを NetMeister によって管理する場合、親機モードの機器と同じのグループに属する必要があります。図 6-2 に示すように、子機モードは、親機モードの機器との通信と NetMeister と直接通信の両方を利用して NetMeister 上で管理され、NetMeister に関する通信は https(ssl)でおこなわれます(デフォルトポート番号: 443)。親機モードは、NetMeister に関する通信は mqtt(デフォルトポート番号:8883)と https(ssl)でおこなわれます。 (デフォルトポート番号:443)

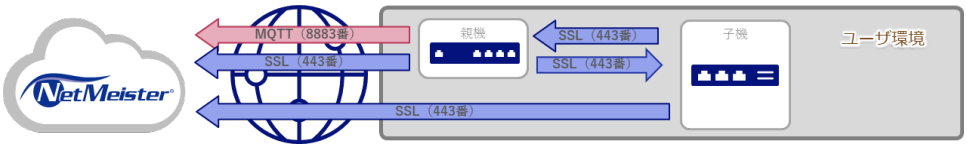

図 6-2 NetMeister への通信イメージ

図 6-3 に示すように、プロキシサーバを用いて外部ネットワークに接続をしている環境でも NetMeister を利用可能です。プロキシサーバのアドレスを設定することで、NetMeister 宛の通信をプロキシサーバ経由でおこなうことが可能です。

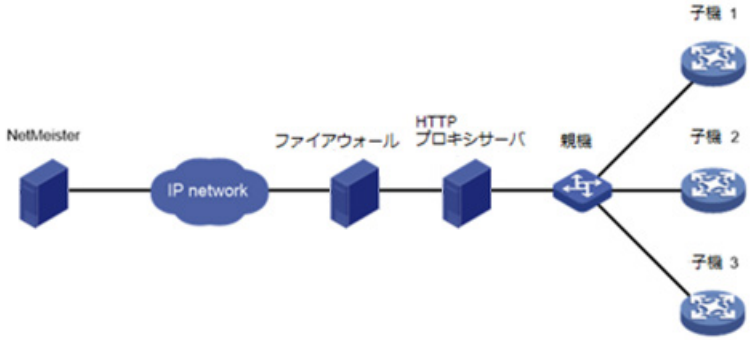

図 6-3 プロキシサーバを用いた NetMeister の利用環境

図 6-4 に示すように、子機で NetMeister への接続に proxy サーバを利用する場合、NetMeister 宛の通信のみ proxy サーバを経由します。親機と子機の間にプロキシサーバ及びファイアウォールがある様な特殊な環境の場合、親機と子機の間の通信を透過させるために、ファイアウォールで親機の LAN 側 IP 宛の通信を許可する必要があります。同様に、ファイアウォールを跨ぐ位置にある NTP サーバ/DNS サーバ/SSH クライアント等との通信をする場合は、それらの許可も必要です。

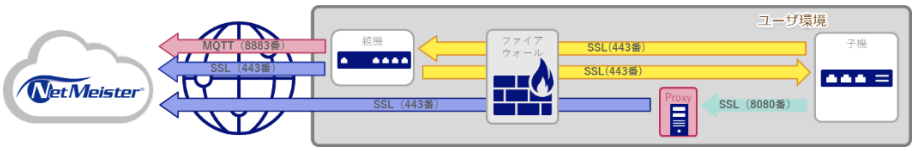

図 6-4 プロキシサーバを用いた NetMeister の通信イメージ

6.1.2 設定手段について

装置を NetMeister で管理をするためには、装置に手動でコンフィグを設定して環境に接続する手段と、ゼロタッチプロビジョニング機能(ZTP 機能)を利用して接続する手段があります。

ゼロタッチプロビジョニング機能は、スタートアップコンフィグレーションファイルを設定されていない状態で装置が起動する場合、NetMeister の親機から受けた DHCP パケットの情報を元に NetMeister から自動でコンフィグレーションファイルを取得し、適用することを可能にします。ゼロタッチプロビジョニング機能は装置に起動コンフィグが設定されていない状態で起動した際に自動で動作します。

図 6-5 に示すように、ゼロタッチプロビジョニング機能を利用する場合、管理者が事前に NetMeister 上に装置情報と利用するコンフィグレーションファイルを登録しておくことで、現場で装置設置をする作業者が、装置の操作をすることなく NetMeister に接続することが可能です。

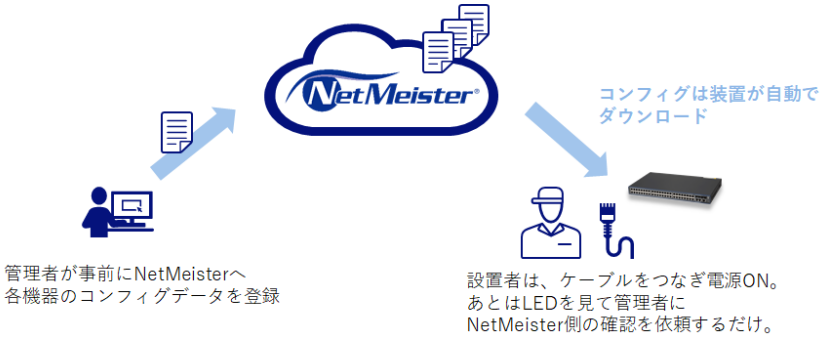

図 6-5 ゼロタッチプロビジョニングのイメージ

ゼロタッチプロビジョニング機能は、Auto Config 機能と交互に実行されます。Auto Config 機能についてはオペレーションマニュアルのセクション 1 はじめに “Auto Config” を参照してください。

6.2 設定作業リスト

作業リスト
手動設定による NetMeister の利用
外部ネットワークへの接続準備 ● (必須設定項目) 自装置の IP アドレスの設定 ● (必須設定項目) 使用する DNS サーバの設定 ● (必須設定項目) ルーティングの設定
NetMeister機能に関係する追加設定 ● (推奨設定項目) 時刻、及び、タイムゾーン(+9:00)の設定 ● (オプション設定項目) Web コンソールユーザの設定 ● (オプション設定項目) SSH ユーザの設定 ● (オプション設定項目) LLDP の設定

作業リスト
NetMeisterを利用するための設定 親機モードの場合 ● (オプション設定項目) NetMeister 上に表示するホスト名の設定 ● (必須設定項目) 親機モードの設定 ● (必須設定項目) グループ ID とグループパスワードの設定 ● (オプション設定項目) MQTT のポート番号の設定 ● (必須設定項目) 拠点 ID の設定 ● (オプション設定項目) プロキシサーバのアドレスの設定 ● (オプション設定項目)注意レベルの NM アラームの送信有効の設定 ● (必須設定項目) NetMeister 機能の有効化 子機モードの場合 ● (オプション設定項目) NetMeister 上に表示するホスト名の設定 ● (必須設定項目) グループ ID とグループパスワードの設定 ● (必須設定項目) 親機の IP アドレスとポート番号の設定 ● (オプション設定項目) プロキシサーバのアドレスの設定 ● (オプション設定項目)注意レベルの NM アラームの送信有効の設定 ● (必須設定項目) NetMeister 機能の有効化
ゼロタッチプロビジョニング機能による NetMeister の利用
事前準備作業 ● (必須設定項目)親機の設定 ● (必須設定項目)コンフィグレーションファイルの準備 ● (必須設定項目)装置情報の確認
NetMeisterへの情報登録 ● (必須設定項目)コンフィグレーションファイルの登録 ● (必須設定項目)装置情報の登録 ● (必須設定項目)プロビジョニングの設定
設置作業 ● (必須設定項目)プロビジョニングの有効化

6.2.1 手動設定による NetMeister の利用

I. 外部ネットワークへの接続準備

NetMeister と通信をするために、装置は親機を通して外部ネットワークに接続できる環境に接続されている必要があります。自装置の IP アドレス、使用する DNS サーバ、ルーティングの設定をしてください。DNS サーバは、親機から通知される NetMeister のアドレスを把握するために必要です。

操作	コマンド	補足
1. system view に移行する	**system-view**	ー
2. VLAN インタフェースを作成し、VLAN interface view に移行する	**interface vlan-interface** vlan-interface-id	ー
3. VLAN インタフェースに IP アドレスを割り当てる	・固定アドレスを割り当てる。 **ip address** *ip-address* { *mask* | *mask-length* } ・DHCPでアドレスを取得する **ip address dhcp**	デフォルト：設定なし

操作	コマンド	補足
4． VLAN view から戻る	**quit**	ー
5． DNS サーバの IP アドレスを指定する	**dns server** *ip-address*	デフォルト：設定なし DHCPサーバから情報を取得する場合は設定の必要はありません。
6． ルーティングの設定をする	**ip route-static** *dest-address* { *mask-length* | *mask* } { *interface-type interface-number* [*next-hop-address*] | *next-hop-address* } [**permanent** | **track** *track-entry-number*] [**preference** *preference*] [**tag** *tag-value*] [**description** text]	デフォルト：設定なし DHCPサーバから情報を取得する場合は設定の必要はありません。

II. NetMeister 機能に関係する追加設定

NetMeister で利用する機能によっては従来の装置機能を設定しておく必要があります。

それぞれの機能の設定手順についてはそれぞれの機能の章を参照してください。

各NetMeister機能についての説明はNetMeisterが提供する操作ガイドをご確認ください。

NetMeister 機能	必要設定	補足
CPU/メモリ/温度/ポートトラフィック情報表示	時刻 （手動/NTP）、及び、タイムゾーン（+9:00）	設定をしない場合、正しいグラフ情報になりません。
HTTPSでリモートログインする	Webコンソール利用設定	
SSHでリモートログインする	SSH接続利用設定	
デバイスマップを見る（L2モード）	LLDP有効化	親機でも設定が必要です。

🕮 メモ:

本追加設定や装置名などの基本情報は NetMeister に接続したタイミングと、その後の周期情報更新で NetMeister に通知されます。NetMeister 接続後にこれらの設定を変更し、即時情報を更新したい場合は **netmeister update** コマンドを実行することで可能です。

III. NetMeister を利用するための設定

1)　親機モードの場合

NetMeister を利用するために、NetMeister 上で設定したグループ ID、グループパスワードを設定してください。MQTT のポート番号は 443 に変更が可能です。

操作	コマンド	補足
1． system view に移行する	**system-view**	ー
2． (オプション設定項目) NetMeister 上に表示するホスト名を設定する	**sysname** sysname	デフォルト：装置名
3． 親機モードを有効にする	**netmeister mode parent**	デフォルト：無効
4． グループ ID とグループパスワードを設定する	**netmeister account** *account* **password { cipher** *cipherPassword* **| simple** *plainPassword* **}**	デフォルト：設定なし

操作	コマンド	補足
5. (オプション設定項目)MQTT のポート番号を設定する	**netmeister parent-mode mqtt port { 8883 | 443]**	デフォルト：8883
6. 拠点名を設定する	**netmeister parent-mode sitename** *string*	デフォルト：設定なし
7. (オプション設定項目)プロキシサーバのアドレスを指定する。	**netmeister proxy url** *url* [**username** *username* **password** { **cipher** | **simple** } *string*]	デフォルト：設定なし
8. (オプション設定項目)注意レベルの NM アラームの送信を有効にする。	**netmeister alarm enable notice**	デフォルト：無効
9. NetMeister 機能の有効化	**netmeister enable**	デフォルト：無効

2)　子機モードの場合

NetMeister を利用するために、NetMeister 上で設定したグループ ID、グループパスワードと、親機の IP アドレス、ポート番号の設定をしてください。プロキシサーバのアドレスを設定すると､NetMeister への https 通信のために任意のプロキシサーバを利用します。

操作	コマンド	補足
1. system view に移行する	**system-view**	ー
2. (オプション設定項目)NetMeister 上に表示するホスト名を設定する	**sysname** sysname	デフォルト：装置名
3. グループ ID とグループパスワードを設定する	**netmeister account** *account* **password { cipher** *cipherPassword* **| simple** *plainPassword* **}**	デフォルト：設定なし
4. 親機の IP アドレスとポート番号を指定する	**netmeister parent ip** *ip-address* **[port** *port-number* **]**	デフォルト：設定なし 最大2つまで設定が可能です。 ポート番号を指定しない場合、デフォルトで443が使用されます。
5. (オプション設定項目)プロキシサーバのアドレスを指定する。	**netmeister proxy url** *url* [**username** *username* **password** { **cipher** | **simple** } *string*]	デフォルト：設定なし
6. (オプション設定項目)注意レベルの NM アラームの送信を有効にする。	**netmeister alarm enable notice**	デフォルト：無効
7. NetMeister 機能の有効化	**netmeister enable**	デフォルト：無効

🕮 **メモ:**

親機モードがおこなう MQTT 通信も **netmeister proxy** コマンドによって proxy サーバを利用します。

IV. NetMeister の表示と維持

すべての view で display コマンドを実行できます。

操作	コマンド
NetMeisterおよび親機との接続状態を表示する	**display netmeister**

6.2.2 ゼロタッチプロビジョニング機能による NetMeister の利用

I. 事前準備作業

🕮 **メモ:**

ゼロタッチプロビジョニング機能の利用可能条件:
親機モードで接続する場合
- DHCP サーバが必要です。
- proxy 経由のゼロタッチプロビジョニングをおこなう場合、同じネットワーク内に proxy 経由で NetMeister に接続している他の親機モードの装置と、Option43 を付与できる DHCP サーバが必要です。
- 装置で利用する正しいコンフィグレーションファイルの事前準備が 1 装置に付きつ必要です。
- 利用する装置の MAC アドレス、シリアルナンバー、装置名の情報が必要です。
- コンフィグダウンロード時は、NetMeister 側でダウンロードの有効時間の指定が必要です。

子機モードで接続する場合
- NetMeister に接続している他の親機モードの装置が必要です。
- Option43 を付与できる DHCP サーバが必要です。
- proxy 経由のゼロタッチプロビジョニングをおこなう場合、NetMeister に接続している他の親機モードの装置が proxy 経由で NetMeister に接続している必要があります。
- 装置で利用する正しいコンフィグレーションファイルの事前準備が 1 装置につき 1 つ必要です。
- 利用する装置の MAC アドレス、シリアルナンバー、装置名の情報が必要です。
- コンフィグダウンロード時は、NetMeister 側でダウンロードの有効時間の指定が必要です。

1) DHCP サーバの設定

ゼロタッチプロビジョニング機能を利用する場合、NetMeister にアクセスするための IP アドレス、ゲートウェイアドレス、DNS サーバ情報は DHCP サーバから取得する必要があります。また、子機モードで利用する場合、または proxy 経由でゼロタッチプロビジョニングを行う場合、親機から情報を得るために Option43 によって親機アドレスを通知する必要があります。

Option43 のフォーマット
NEC,zerotouch,<親機IPv4アドレス>,<親機待ち受けポート> 例）**NEC,zerotouch,192.0.2.1,443**

NetMeister 機能のゼロタッチプロビジョニング子機対応機能(QX 未サポート)をサポートする親機を DHCP サーバとして利用する場合、ゼロタッチプロビジョニング用の DHCP リクエストにだけ Option43 の情報を通知することが可能です。NetMeister

機能のゼロタッチプロビジョニング子機対応に関しては NetMeister 操作ガイドを参照してください。

2) コンフィグレーションファイルの準備

ゼロタッチプロビジョニング機能で設定を行う対象装置のために、コンフィグファイルをテキストで作成し、zip 圧縮してください。間違ったコンフィグファイルを使用しないよう、あらかじめ実機で確認をしたコンフィグを使用することを推奨します。

下記にコンフィグレーションファイルのサンプルを示します。

親機モードのコンフィグレーションのサンプル

```
#
local-user nec
 password simple qx12345678
 service-type https ssh
 authorization-attribute user-role admin
#
ip https enable
#
line vty 0
 authentication-mode scheme
#
ssh server enable
#
interface Vlan-interface1
 ip address dhcp
#
clock timezone JST add 09:00:00
#
ntp-service unicast-server 1.1.1.2
ntp-service enable
#
lldp global enable
#
 netmeister mode parent
 netmeister account test password simple abcdefg
 netmeister parent-mode sitename kyoten1
 netmeister parent-mode mqtt port 443
 netmeister enable
#
```

子機モードのコンフィグレーションのサンプル

```
#
local-user nec
 password simple qx12345678
 service-type https ssh
 authorization-attribute user-role admin
#
ip https enable
#
line vty 0
 authentication-mode scheme
#
ssh server enable
#
interface Vlan-interface1
 ip address dhcp
#
clock timezone JST add 09:00:00
#
ntp-service unicast-server 1.1.1.2
ntp-service enable
#
lldp global enable
#
 netmeister account test password simple abcdefg
 netmeister parent ip 1.1.1.1 port 443
 netmeister enable
#
```

3) 装置情報の確認

ゼロタッチプロビジョニング機能を利用する装置の MAC アドレス、シリアルナンバー、装置名の情報を確認してください。 MAC アドレス、シリアルナンバー、装置名は、梱包箱または装置の本体ラベルに記載されています。

II. NetMeister への情報登録

NetMeister にログインしてください。(NetMeister を利用するためのアカウントおよびグループの作成についての説明は省略します。NetMeister 操作ガイドを確認してください。)

1) NetMeister でのゼロタッチプロビジョニングは、NetMeister 画面左側メニューの「設定」からおこないます。

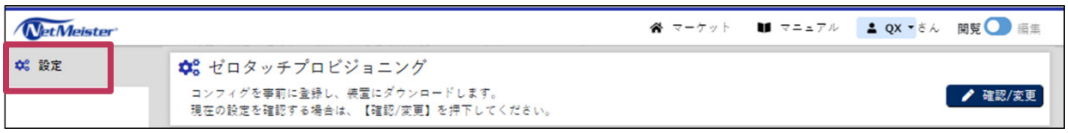

図 6-6 設定メニューの表示

2)　ゼロタッチプロビジョニングの設定のために編集モードにします。

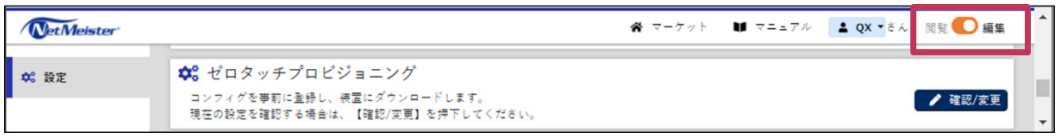

図 6-7 編集モードへの変更

3)　コンフィグレーションファイルを NetMeister 上に登録します。

図 6-8 コンフィグ登録画面

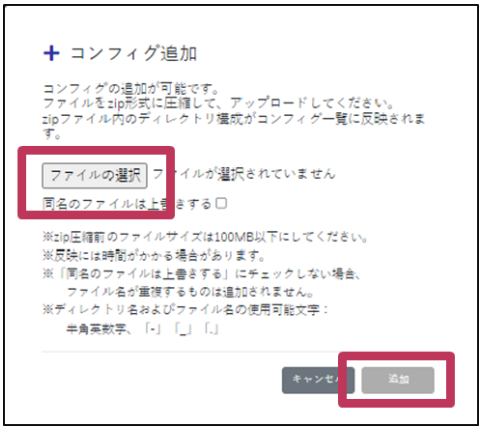

図 6-9 コンフィグの選択

メモ:

NetMeister へのコンフィグレーションファイルの登録は zip 形式でおこないます。複数のコンフィグレーションファイルをフォルダに格納して zip 圧縮しておくことで一度に登録も可能です。

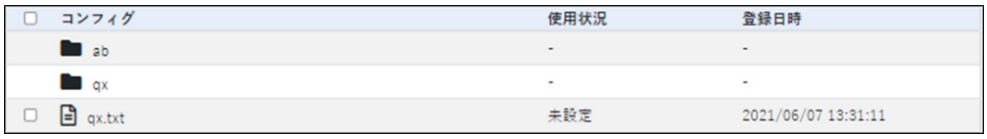

図 6-10 コンフィグ登録後の表示

4)　ゼロタッチプロビジョニングを利用する装置情報を登録します。

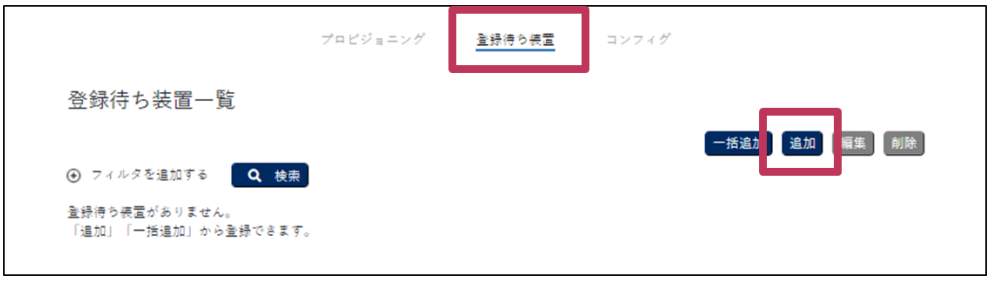

図 6-11 登録待ち装置設定画面

図 6-12 装置情報の登録例

メモ:

装置情報の登録では、シリアル番号の入力は大文字小文字を区別します。
MAC アドレスの入力は大文字小文字を区別しません。
「：」「-」などは含めないでください。
シリーズ名、機種名の選択を間違えないよう注意してください。

図 6-13 登録後の表示

5)　登録したコンフィグレーションファイルと装置情報を紐づけます。

図 6-14 プロビジョニングの設定画面

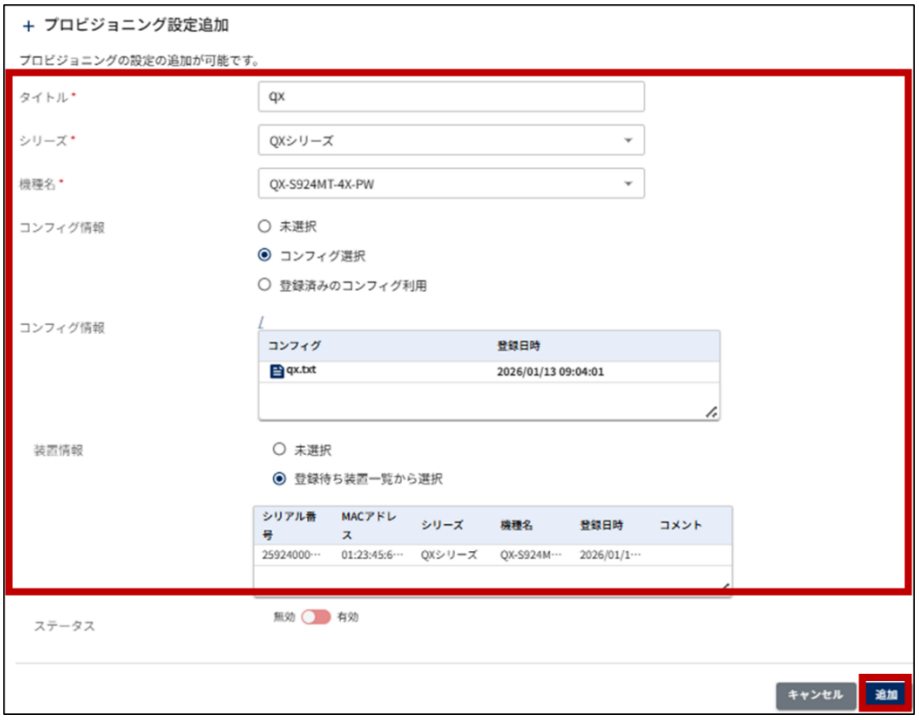

図 6-15 装置とコンフィグの選択

メモ:

タイトルは任意の文字列を入力してください。
シリーズ名と装置名を選択すると、他は選択可能なものだけが表示されますので任意の組み合わせを選択してください。
設置作業者がすぐに作業をしない場合はステータスを[無効]で登録しておきます。

III. 設置作業

1)　設置作業者が作業する時間を考慮し、コンフィグのダウンロード可能時間を設定します。一覧から対象の行を選択すると、現在の設定情報が下に表示されます。

図 6-16 プロビジョニング設定一覧

2)　選択した設定のステータスを[編集]から有効にし、コンフィグダウンロード可能時間を設定します。

図 6-17 ステータスの変更と DL 有効時間の設定

メモ:

有効時にダウンロード後の無効パターンを指定できますが、QX のゼロタッチプロビジョニングは、ダウンロード完了時はコンフィグを次回起動のコンフィグとして保存、再起動しますので、どちらを選んでも 1 度のみの取得動作です。(次回以降の起動時は保存済のコンフィグを使用して起動します。）

3)　設置場所で設置作業者が指定の装置を開梱します。
4)　準備後、管理者に装置設置開始の連絡をします。
5)　管理者は NetMeister 上で対象のゼロタッチプロビジョニングの有効化をします。
6)　設置作業者は指定の環境に装置を接続します。
7)　接続した装置は NetMeister から自動的にコンフィグを取得します。

QX のゼロタッチプロビジョニングでは、取得したコンフィグデータを自動で次回起動のコンフィグとしてセットし、再起動します。

DHCP サーバの設定ミスやインターネット環境に出られない環境など、何らかの理由で失敗している場合はリトライを繰り返し、再起動はしません。環境を見直してください。ゼロタッチプロビジョニングのプロセスを止めるためには、CLI で<Ctrl+C>または<Ctrl+D>を押下してください。

8)　再起動を LED 変化で確認し、管理者に連絡します。

起動時の LED 変化は下記の通りです。

表 6-1 QX-S4800X シリーズ

状態	LED
Boot 起動中	緑点滅
System 起動中	緑点滅
ゼロタッチプロビジョニング中	緑点灯、LinkUp ポート LED 点灯
ゼロタッチプロビジョニング成功時	(自動再起動)オレンジ点灯
コンフィグ読み込み中	緑点滅
起動完了	緑点灯、LinkUp ポート LED 点灯

9)　NetMeister 上で状態を確認します。

図 6-18 動作状態の確認

結果がダウンロード成功の場合、コンフィグ取得を終えています。装置詳細画面に装置が表示されたことをチェックしてください。装置情報の誤入力や、環境の問題で NetMeister にアクセスができていない場合はカウントがされません。

図 6-19 装置一覧の確認

装置が再起動し、起動したにもかかわらず装置一覧に表示されない場合、準備されたコンフィグに NetMeister に接続するための設定の不備がある可能性があります。

装置一覧に装置が表示されれば NetMeister で管理ができています。

IV. 参考

NetMeister であらかじめアカウント管理から通知設定でゼロタッチ通知にチェックをいれておくと、ゼロタッチプロビジョニングによるコンフィグ取得成功時にメールが通知されます。

図 6-20 アカウント管理

図 6-21 通知の設定

6.3 NetMeisterによる管理

NetMeister の操作、及び、対応機能に関しては、NetMeister が提供する操作ガイドをご確認ください。

https://www.necplatforms.co.jp/product/netmeister/

6.3.1 タブ一覧

NetMeister 上の装置詳細の画面に表示されるタブは、機器ごとに表示される内容が異なり、NetMeister prime の利用によって表示、利用可能になる機能もあります。詳細は NetMeister が提供する操作ガイドをご確認ください。

また、表示のレイアウトは NetMeister 側の更新によって変わる可能性があります。

本装置は以下のタブに対応しています。

タブ名	説明
装置概要	装置の詳細画面を表示します。 詳細はNetMeisterが提供する操作ガイドをご確認ください。
アラーム	温度センサや FAN を持たない装置はそれらのアラームを送信することはありません。S900 の温度のしきい値はシステム管理の各種しきい値設定値に依存します。CPU、メモリのアラームしきい値は CPU=95%、メモリ=85%固定です。 その他の対応アラームはNetMeisterが提供する操作ガイドをご確認ください。
デバイスリスト	MAC テーブルと ARP テーブルを合わせた情報を表示します。
コンフィグ	NetMeister 上にコンフィグを保存、装置の次回起動コンフィグとの比較、反映が可能です。
ログ	NetMeister から定期的に装置情報を取得し、NetMeister に保存できます。装置ごとに、時間帯を指定できます。
VLAN	display vlan コマンド、及び、display interface vlan コマンド相当の情報を表示します。
ポート状態	物理インタフェースの情報を表示します。

6.4 NetMeisterの表示と維持

操作	コマンド
NetMeister との接続状態を表示する	**display netmeister**

🕮 **メモ:**

display netmeister コマンドで表示する情報は装置から親機、及び、NetMeister への接続に関する状態です。装置からの通信に問題が無く、NetMeister、親機から装置への要求メッセージが届いていない場合などは、NetMeister 上の状態表示と装置側の状態情報は一致しない場合があります。

6.5 NetMeisterの設定例

6.5.1 親機モードでの NetMeister 接続

I. ネットワーク要件

図 6-22 に示すように、Device A に親機モードの設定をします。

- あらかじめ NetMeister 上で「アカウント登録」をし、「グループ登録」としてグループ ID(aaa)とグループパスワード(bbb)が設定されていることとします。
- DNS サーバとして 10.0.0.254 が動作していることとします。

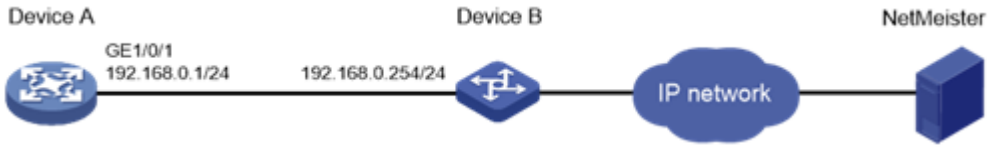

図 6-22 ネットワーク図

II. 設定手順

1. 外部ネットワークへの接続準備をします。

#VLAN インタフェースを作成し、IP アドレスをインタフェースに割り当てます。

```
<DeviceA> system-view
[DeviceA] vlan 1
[DeviceA-vlan1] quit
[DeviceA] interface vlan-interface 1
[DeviceA -Vlan-interface1] ip address 192.168.0.1 24
[DeviceA -Vlan-interface1] quit
```

DNS サーバを指定します。

```
[DeviceA] dns server 10.0.0.254
```

ルーティング設定をします。

```
[DeviceA] ip route-static 0.0.0.0 0 192.168.0.254
```

2. その他の追加機能の設定をします。

時刻とタイムゾーン(+9:00)の設定をします。

```
[DeviceA] clock timezone JST add 09:00:00
[DeviceA] ntp-service enable
[DeviceA] ntp-service unicast-server 192.168.0.254
```

ssh と web コンソールアクセス用の設定をします。

```
[DeviceA]ssh server enable
[DeviceA]ip https enable
[DeviceA]line vty 0
[DeviceA-line-vty0]authentication-mode scheme
[DeviceA-line-vty0]local-user nec
[DeviceA-luser-manage-nec]password simple qx12345678
[DeviceA-luser-manage-nec]service-type https ssh
[DeviceA-luser-manage-nec]authorization-attribute user-role admin
[DeviceA-luser-manage-nec]quit
```

lldp の有効化をします。

```
[DeviceA] lldp global enable
```

3. NetMeister を利用するための設定をします。

親機モードを利用するための設定をします。

```
[DeviceA] netmeister mode parent
```

グループ ID(aaa)とグループパスワード(bbb)を設定します。

```
[DeviceA] netmeister account aaa password simple bbb
```

親機モードで NetMeister に接続する際の MQTT のポート番号を 443 に変更します。

```
[DeviceA] netmeister parent-mode mqtt port 443
```

親機モードで利用するための拠点 id(kyoten1)を指定します。

```
[DeviceA] netmeister parent-mode sitename kyoten1
```

NetMeister 機能の有効化をします。

```
[DeviceA] netmeister enable
```

III. 設定の確認

1. 外部ネットワークと疎通ができることを確認するために、いずれかの外部ネットワークと ping の疎通ができることを確認します。

```
<DeviceA>ping 1.1.1.1
PING 1.1.1.1 (1.1.1.1) 56(84) bytes of data.
64 bytes from 1.1.1.1: icmp_seq=1 ttl=64 time=1.15 ms
64 bytes from 1.1.1.1: icmp_seq=2 ttl=64 time=0.657 ms
64 bytes from 1.1.1.1: icmp_seq=3 ttl=64 time=0.687 ms
64 bytes from 1.1.1.1: icmp_seq=4 ttl=64 time=0.654 ms
64 bytes from 1.1.1.1: icmp_seq=5 ttl=64 time=0.693 ms

--- 1.1.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4052ms
rtt min/avg/max/mdev = 0.654/0.767/1.146/0.189 ms
```

2. NetMeister および親機との接続状態を確認します。

```
<DeviceA> display netmeister
NetMeister state          :  Enabled
Mode                      :  Parent
Connection state with NetMeister:  Connected
Account name              :  aaa
Event log                 :  Enabled
Proxy information:
State                     :  --
Parent information:
Site name                 :  kyoten1
Interval                  :  3600 sec
MQTT interval             :  60 sec
MQTT status               :  Connected
```

メモ:

- NetMeister prime を利用していない場合、親機モードの QX は接続を完了できません。NetMeister の操作ガイドを参照し、ライセンス適用を行ってください。

6.5.2 子機モードでの NetMeister 接続

I. ネットワーク要件

図 6-23 に示すように、Device B を親機とし、Device A に子機モードの設定をします。

- あらかじめ NetMeister 上で「アカウント登録」をし、「グループ登録」としてグループ ID(aaa)とグループパスワード(bbb)が設定されていることとします。
- あらかじめ親機は外部ネットワークに接続するための設定を行い、グループ ID(aaa)に属していることとします。
- DNS サーバとして 10.0.0.254 が動作していることとします。

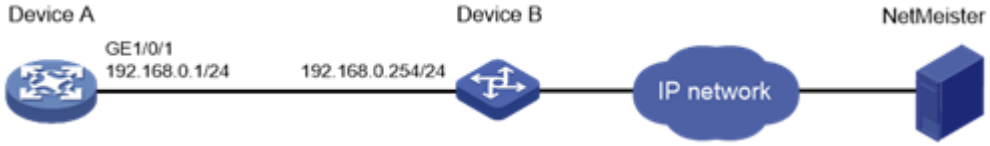

図 6-23 ネットワーク図

II. 設定手順

1. 外部ネットワークへの接続準備をします。

#VLAN インタフェースを作成し、IP アドレスをインタフェースに割り当てます。

```
<DeviceA> system-view
[DeviceA] vlan 1
[DeviceA-vlan1] quit
[DeviceA] interface vlan-interface 1
[DeviceA -Vlan-interface1] ip address 192.168.0.1 24
[DeviceA -Vlan-interface1] quit
```

DNS サーバを指定します。

```
[DeviceA] dns server 10.0.0.254
```

ルーティング設定をします。

```
[DeviceA] ip route-static 0.0.0.0 0 192.168.0.254
```

2. その他の追加機能の設定をします。

時刻とタイムゾーン(+9:00)の設定をします。

```
[DeviceA] clock timezone JST add 09:00:00
[DeviceA] ntp-service enable
[DeviceA] ntp-service unicast-server 192.168.0.254
```

ssh と web コンソールアクセス用の設定をします。

```
[DeviceA]ssh server enable
[DeviceA]ip https enable
[DeviceA]line vty 0
[DeviceA-line-vty0]authentication-mode scheme
[DeviceA-line-vty0]local-user nec
[DeviceA-luser-manage-nec]password simple qx12345678
[DeviceA-luser-manage-nec]service-type https ssh
[DeviceA-luser-manage-nec]authorization-attribute user-role admin
[DeviceA-luser-manage-nec]quit
```

lldp の有効化をします。

```
[DeviceA] lldp global enable
```

3. NetMeister を利用するための設定をします。

グループ ID(aaa)とグループパスワード(bbb)を設定します。

```
[DeviceA] netmeister account aaa password simple bbb
```

親機の IP アドレスとポート番号(デフォルト:443)を指定します。

```
[DeviceA] netmeister parent ip 192.168.0.254 port 443
```

NetMeister 機能の有効化をします。

```
[DeviceA] netmeister enable
```

III. 設定の確認

1. 外部ネットワークと疎通ができることを確認するために、いずれかの外部ネットワークと ping の疎通ができることを確認します。

```
<DeviceA>ping 1.1.1.1
PING 1.1.1.1 (1.1.1.1) 56(84) bytes of data.
64 bytes from 1.1.1.1: icmp_seq=1 ttl=64 time=1.15 ms
64 bytes from 1.1.1.1: icmp_seq=2 ttl=64 time=0.657 ms
64 bytes from 1.1.1.1: icmp_seq=3 ttl=64 time=0.687 ms
64 bytes from 1.1.1.1: icmp_seq=4 ttl=64 time=0.654 ms
64 bytes from 1.1.1.1: icmp_seq=5 ttl=64 time=0.693 ms

--- 1.1.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4052ms
rtt min/avg/max/mdev = 0.654/0.767/1.146/0.189 ms
```

2. NetMeister および親機との接続状態を確認します。

```
<DeviceA> display netmeister
NetMeister state                          :  Enabled
Connection state with NetMeister          :  Connected
Account name                              :  aaa
Parent 1:
 IP address                               :  192.168.0.254
 Port number                              :  443
 Connection state                         :  Connected
```

6.6 NetMeister利用のトラブルシューティング

NetMeister 操作ガイドにも装置毎の機能対応一覧、及び、NetMeister 機能に関する注意事項、FAQ が記載されていますので参照して下さい。

6.6.1 NetMeister に QX が登録できない

I. 症状

QX で NetMeister を利用したいが NetMeister に装置が登録できない。

II. 解決策

子機モードで利用する場合

1) 同一グループに既に親機モードで登録されていないか確認し、登録されている場合は装置削除します。
2) 親機となる装置(IX/WA)が NetMeister に接続できているか確認します。

3) 子機で設定したグループ ID およびパスワードが親機で設定しているものと同じであるか確認します。
4) 子機から外部ネットワークに DNS を使用した通信ができることを確認します。
5) 問題が解決しない場合、NetMeister のお問い合わせフォームより、お問い合わせください。

親機モードで利用する場合

1) 同一グループに既に子機モードで登録されていないか確認し、登録されている場合は装置削除します。
2) NetMeister 上のライセンスの数が十分か確認します。
3) 外部ネットワークに DNS を使用した通信ができることを確認します。
4) 問題が解決しない場合、NetMeister のお問い合わせフォームより、お問い合わせください。

6.6.2 NetMeister でグラフが正しく表示されない。

I. 症状

QX の装置詳細画面でグラフ情報が正しく表示されない。

II. 解決策

1) 装置にタイムゾーン(+9:00)が設定されていることを確認します。
2) 装置の時刻が正しいことを確認します。
3) NetMeister に装置登録した後に時刻設定を変更した場合は、周期的な装置情報更新のために、1 時間待つか NetMeister 機能を一度無効にし、再度有効にします。
4) 問題が解決しない場合、NetMeister のお問い合わせフォームより、お問い合わせください。

6.6.3 NetMeister のリモートログインが使えない

I. 症状

QX にリモートログインができない。

II. 解決策

1) 装置に ssh または web コンソール接続の設定がされてあることを確認します。
2) リモートログインでのアクセスに利用する PC がプライベートアドレスではないことを確認します。
3) 操作 PC と対象の装置間でファイアウォールやフィルタなど、通信制限がない事を確認します。
4) 環境がプロキシやファイアウォールを利用していないことを確認します。
5) 問題が解決しない場合、NetMeister のお問い合わせフォームより、お問い合わせください。

6.6.4 ファームウェア更新が成功しない

I. 症状

NetMeister で管理している装置のファームウェア更新(バージョンアップ)が成功しない。

II. 解決策

1) タスク一覧からタスクの状態を確認します。
2) タスク結果が失敗と表示され、詳細理由にディレクトリサイズが足りない、または、セットに失敗したと表示されている場合、装置のディレクトリサイズが不足していますので不要なファイルを削除します。

🕮 メモ:

ファームウェア更新をするためには、NetMeister から取得するソフトウェアを格納する分のディレクトリの空き容量が必要です。
NetMeister 機能[コマンド実行]によって、NetMeister からディレクトリ確認コマンド(**dir**)及び削除コマンド(**delete**)等の実行が可能です。

---

3) 問題が解決しない場合、NetMeister のお問い合わせフォームより、お問い合わせください。

6.6.5 NetMeisterPrime 機能が使用できない

I. 症状

NetMeister に prime ライセンスを適用(またはトライアル)したが機能が使用できない。

II. 解決策

1) NetMeister メニューからライセンスの適用状態を確認し、適用されていない場合は適用操作をします。(NetMeister が提供する NetMeister 操作ガイド参照)
2) 子機モードの場合、手動で有償化操作をする必要があります。
3) prime 機能にはライセンス適用時に即座に利用できるものと、周期的な装置情報更新のタイミングで識別され使用可能になる機能がありますので、1 時間待つか NetMeister 機能を一度無効にし、再度有効にします。
4) 問題が解決しない場合、NetMeister のお問い合わせフォームより、お問い合わせください。

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7章 NQA の設定

> 🕮 メモ：
> NQA 機能は。Version1.1.18 を含む以降のソフトウェアからサポートしています。

7.1. 概要

ネットワーク品質アナライザ(NQA)を使用すると、ネットワークのパフォーマンスを測定します。IP サービスおよびアプリケーションのサービスレベルを確認し、ネットワークの問題をトラブルシューティングすることができます。NQA では、以下の操作が可能です。

- ICMP エコー。

図 7-1 に示すように、NQA 送信側デバイス（NQA クライアント）は、IP サービスやアプリケーションをシミュレートして NQA 受信側デバイスにデータを送信し、ネットワークパフォーマンスを測定します。取得されるパフォーマンス指標には、片方向遅延、ジッター、パケットロスなどが含まれます。

図 7-1 ネットワーク図

7.1.1. NQA の動作

以下に、NQA の動作について説明します。

- ICMP エコー操作では、ICMP エコー要求が送信されます。

7.1.2. Track との連携

NQA は Track モジュールと連携し、状態やパフォーマンスの変化をアプリケーションモジュールに通知することで、アプリケーションモジュールが事前に定義されたアクションを実行できるようにします。

NQA と Track の連携は、以下のアプリケーションモジュールで利用可能です：

- PoE。

7.1.3. しきい値監視

しきい値監視により、NQA 操作のパフォーマンスメトリクスが指定されたしきい値を超えた場合、NQA クライアントが事前に定義されたアクションを実行できるようになります。

表 7-1 には、パフォーマンスメトリクスと NQA 操作タイプとの関係が記載されています。

表 7-1 パフォーマンス指標と NQA 操作タイプ

パフォーマンス指標	その指標を収集できる NQA 操作タイプ
プローブの継続時間	ICMPエコー
プローブ失敗数	ICMPエコー

7.2. NQA設定タスク一覧

タスクの概要	補足
（必須） NQA クライアントの有効化	―
（必須）以下のタスクのうち、少なくとも1つを実行してください。 NQA クライアントでの NQA 操作の設定	ネットワークパフォーマンスを分析するために NQA テンプレートを設定すると、そのテンプレートを使用する機能が NQA 操作を実行します。

7.2.1. NQA クライアントの有効化

操作	コマンド	補足
system view に移行する	system-view	―
NQA クライアントを有効にする	nqa agent enable	デフォルト：有効 NQAクライアントを有効にしたのちNQAの設定が適用されます。

7.2.2. NQA クライアントでの NQA 操作の設定

I. NQA 操作の設定タスク一覧

タスクの概要
（必須）次のタスクを実行します。 ・ICMPエコー操作の設定
（オプション） NQA 操作のオプションパラメータの設定
（オプション） コラボレーション機能の設定
（オプション） しきい値監視の設定
（オプション） NQA 統計情報収集機能の設定

（オプション） NQA 履歴レコードの保存設定
（必須） NQA クライアントでの NQA 操作のスケジュール設定

II. ICMP エコー操作の設定

ICMP エコー操作は、宛先デバイスの到達可能性を測定します。これは ping コマンドと同じ機能を持ちますが、より多くの出力情報を提供します。また、送信元デバイスと宛先デバイスの間に複数の経路 が存在する場合、ICMP エコー操作のネクストホップを指定することができます。

ICMP エコー操作を設定するには、次の手順を実行します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NQA 操作を作成し、NQA 操作 view に移行する	**nqa entry** *admin-name operation-tag*	デフォルトでは、NQA操作は存在しません。
3. ICMP エコータイプを指定し、その view に移行する	**type icmp-echo**	―
4. ICMP エコー要求の宛先 IP アドレスを指定する	**destination ip** *ip-address*	デフォルトでは、宛先IPアドレスは指定されません。
5. （オプション）ICMP エコー要求の送信元 IP アドレスを指定する	**source ip** *ip-address*	デフォルトでは、リクエストの送信元IPアドレスとして、出力インタフェースのプライマリIPアドレスが使用されます。**source ip** コマンドを複数回実行した場合、最新の設定が有効になります。指定する送信元IPアドレスはローカルインタフェースのIPアドレスである必要があり、そのインタフェースはアクティブである必要があります。そうでない場合、プローブパケットを送信することはできません。
6. （オプション）ICMP エコー要求のネクストホップ IP アドレスを指定する	**next-hop ip** *ip-address*	デフォルトでは、ネクストホップIPアドレスは設定されていません。

III. NQA 操作のオプションパラメータの設定

パラメータの設定は、現在の操作に対してのみ有効になります。

NQA 操作のオプションパラメータを設定するには、次の手順を実行します。

操作	コマンド	補足

1. system view に移行する	**system-view**	―
2. NQA 操作を作成し、NQA 操作 view に移行する	**nqa entry** *admin-name operation-tag*	デフォルトでは、NQA操作は存在しません。
3. NQA 操作のタイプを指定して、その view に移行する	**type icmp-echo**	―
4. 説明を設定する	**description** *text*	デフォルトでは、説明は設定されていません。
5. NQA 操作が繰り返される間隔を設定する	**frequency** *interval*	デフォルト設定は0ミリ秒で、1回の操作のみが実行されます。 間隔が経過しても操作が完了していない場合、次の操作は開始されません。
6. プローブの実行回数を指定する	**probe** *count*	デフォルトでは、NQAクライアントは1回の操作につき、宛先に対して1回のプローブを実行します。
7. プローブのタイムアウト時間を設定する	**probe timeout** *timeout*	デフォルト設定は3000ミリ秒です。

IV.　コラボレーション機能の設定

コラボレーションは、NQA 操作のリアクションエントリをトラックエントリに関連付けることで実装されます。リアクションエントリは、NQA 操作を監視します。操作の失敗回数が指定されたしきい値に達すると、設定されたアクションがトリガーされます。

コラボレーション機能を設定するには、次の手順を実行します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NQA 操作を作成し、NQA 操作 view に移行する	**nqa entry** *admin-name operation-tag*	デフォルトでは、NQA操作は存在しません。
3. NQA 操作のタイプを指定して、その view に移行する	**type icmp-echo**	―
4. リアクションエントリを設定する	**reaction** *item-number* **checked-element probe-fail threshold-type consecutive** *consecutive-occurrences* **action-type trigger-only**	デフォルトでは、リアクションエントリは設定されていません。 既存のリアクションエントリの内容を変更することはできません。
5. system view に戻る	**quit**	―
6. Track を NQA に関連付ける	**「高可用性」を参照してください。**	―

7. Track をアプリケーションモジュールに関連付ける	「高可用性」を参照してください。	―

V. しきい値監視の設定

この機能により、NQA の動作状況を監視できます。

1) しきい値の種類

NQA 操作では、以下のしきい値タイプがサポートされています。

- **平均** - 監視対象のパフォーマンス指標の平均値が、上限しきい値を超えたり、下限しきい値を下回ったりした場合、しきい値違反が発生します。
- **累積** - 監視対象のパフォーマンス指標が指定された値の範囲外となる総回数が、指定されたしきい値に達するか、またはそれを超えると、しきい値違反が発生します。
- **consecutive** - 監視対象のパフォーマンス指標が指定された値の範囲外となる連続回数が、指定されたしきい値に達するか、またはそれを超えると、しきい値違反が発生します。

平均または累積のしきい値タイプにおけるしきい値違反は、NQA 操作ごとに判定されます。連続タイプのしきい値違反は、NQA 操作が開始された時点から判定されます。

2) トリガーされるアクション

以下のアクションがトリガーされる可能性があります：

- **trigger-only** - NQA は結果を端末画面に表示し、その間に連携のために他のモジュールをトリガーします。

3) リアクションエントリ

リアクションエントリでは、監視対象要素、しきい値タイプ、およびトリガーされるアクションを設定して、しきい値監視を実装します。

リアクションエントリの状態は、「無効」、「しきい値超過」、または「しきい値未満」のいずれかになります。

- NQA の動作が開始される前は、リアクションエントリは「無効」の状態です。
- しきい値が違反された場合、エントリの状態は「しきい値超過」に設定されます。それ以外の場合は、エントリの状態は「しきい値未満」に設定されます。

4) 設定手順

しきい値監視を設定するには、次の手順を実行します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NQA 操作を作成し、NQA 操作 view に移行する	**nqa entry** *admin-name operation-tag*	デフォルトでは、NQA 操作は存在しません。
3. NQA 操作 view に移行する	**type icmp-echo**	―
4. しきい値監視を設定する	**reaction** *item-number* **checked-element probe-fail threshold-type {accumulate** *accumulate-occurrences* | **consecutive** *consecutive-occurrences*}	―

VI. NQA 統計情報収集機能の設定

NQA は、統計グループと同じ収集間隔で統計情報を生成します。統計グループに関する情報を表示するには、**display nqa statistics** コマンドを使用します。

frequency コマンドを使用して NQA 操作の間隔を 0 ミリ秒に設定した場合、NQA はその操作に関する統計グループを生成しません。

NQA 統計情報収集機能を設定するには、次の手順を実行します。

操作	コマンド	補足
1. system view に移行する	system-view	―
2. NQA 操作を作成し、NQA 操作 view に移行する	**nqa entry** *admin-name operation-tag*	デフォルトでは、NQA 操作は存在しません。
3. NQA 操作のタイプを指定する	**type icmp-echo**	―
4. (オプション) 統計情報を収集する間隔を設定する	**statistics interval** *interval*	デフォルト設定は60分です。
5. (オプション) 保存できる統計グループの最大数を設定する	**statistics max-group** *数*	デフォルト設定は2グループです。 NQAの統計情報収集機能を無効にするには、最大数を0に設定してください。 統計グループの最大数に達した場合、新しい統計グループを保存するには、最も古い統計グループが削除されます。
6. (オプション) 統計グループの保持期間を設定する	**statistics hold-time** *hold-time*	デフォルト設定は120分です。 統計グループは、保持時間が経過すると削除されます。

VII. NQA 履歴記録の保存の設定

操作	コマンド	補足
1. system view に移行する	system-view	―
2. NQA エントリを作成し、NQA operation view に移行する	**nqa entry** *admin-name operation-tag*	デフォルトでは、NQA 操作は存在しません。
3. NQA operation type view に移行する	**type icmp-echo**	―
4. NQA 操作の履歴記録の保存を有効にする	**history-record enable**	デフォルトでは、この機能は有効になっていません。
5. (オプション設定項目) 履歴記録の有効期間を設定する	**history-record keep-time** *keep-time*	デフォルト設定は120分です。 有効期限に達すると、記録は削除されます。

6. (オプション設定項目) 保存できる履歴記録の最大数を設定する	**history-record number** *number*	デフォルト設定は50です。 NQA 操作の履歴記録の最大数に達した場合、最も古い履歴レコードが削除されます。
7. (オプション設定項目) NQA の履歴記録を表示する	**display nqa history**	―

VIII. NQA クライアントでの NQA 操作のスケジュール設定

NQA 操作は、指定された開始時刻から終了時刻（開始時刻に操作の所要時間を加えた時刻）までの間に行われます。現在のシステム時刻を表示するには、**display clock** コマンドを使用します。

NQA 操作をスケジュールする際は、以下の制限事項とガイドラインに従ってください。

- スケジュールされた NQA 操作の「operation type view」または「operation view」にはアクセスできません。

NQA クライアントで NQA 操作をスケジュールするには、次の手順を実行します。

操作	コマンド	補足
1. system view に移行する	system-view	―
2. NQA 操作のスケジューリングパラメータを指定する	**nqa schedule** *admin-name operation-tag* **start-time** {*hh:mm:ss* [*yyyy/mm/dd* | *mm/dd/yyyy*] | **now**} **lifetime** {*lifetime* | **forever**} [**recurring**]	―

7.3. NQA の表示と保守

任意の view で**表示**コマンドを実行します。

タスク	コマンド
NQA 操作の履歴レコードを表示	**display nqa history** [*管admin-name operation-tag*]
NQA 操作の最新の結果を表示	**display nqa result** [*admin-name operation-tag*]
NQAの統計情報を表示	**display nqa statistics** [*admin-name operation-tag*]

7.4. NQAの設定例

7.4.1. ICMP エコー操作の設定例

I. ネットワーク要件

図 7-2 に示すように、デバイス B までの往復時間をテストするために、NQA クライアント（デバイス A）で ICMP エコー操作を設定します。デバイス A のネクストホップはデバイス C です。

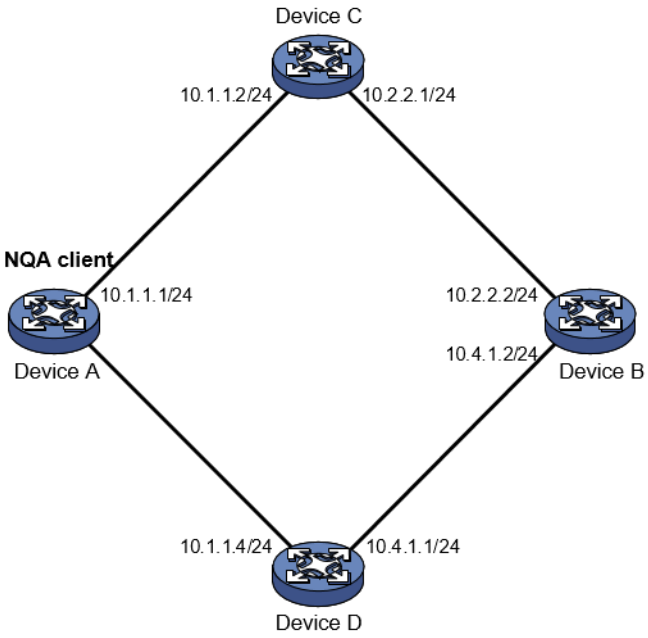

図 7-2 ネットワーク図

II. 設定手順

図 7-2 に示すように、インタフェースに IP アドレスを割り当てます。（詳細は省略します。）

デバイス同士が相互に通信できるように、静的ルートまたはルーティングプロトコルを設定します。（詳細は省略します。）

ICMP エコー操作を作成します。

```
<DeviceA> system-view
[DeviceA] nqa entry admin test1
[DeviceA-nqa-admin-test1] type icmp-echo
```

ICMP エコー要求の宛先 IP アドレスとして 10.2.2.2 を指定します。

```
[DeviceA-nqa-admin-test1-icmp-echo] destination ip 10.2.2.2
```

ネクストホップとして 10.1.1.2 を指定します。ICMP エコー要求は、デバイス C を経由してデバイス B へ送信されます。

```
[DeviceA-nqa-admin-test1-icmp-echo] next-hop ip 10.1.1.2
```

ICMP エコー操作を 10 回実行するように設定します。

```
[DeviceA-nqa-admin-test1-icmp-echo] probe count 10
```

ICMPエコー操作のプローブタイムアウト時間を500ミリ秒に設定します。

```
[DeviceA-nqa-admin-test1-icmp-echo] probe timeout 500
```

ICMPエコー操作を5000ミリ秒ごとに繰り返すように設定します。

```
[DeviceA-nqa-admin-test1-icmp-echo] frequency 5000
```

履歴レコードの保存を有効にします。

```
[DeviceA-nqa-admin-test1-icmp-echo] history-record enable
```

履歴レコードの最大数を10に設定します。

```
[DeviceA-nqa-admin-test1-icmp-echo] history-record number 10
[DeviceA-nqa-admin-test1-icmp-echo] quit
```

ICMPエコー操作を開始します。

```
[DeviceA] nqa schedule admin test1 start-time now lifetime forever
```

ICMPエコー操作を一定時間実行した後、操作を停止します。

```
[DeviceA] undo nqa schedule admin test1
```

ICMPエコー操作の最新の結果を表示します。

```
[DeviceA] display nqa result admin test1
NQA entry (admin admin, tag test1) test results:
    Send operation times: 10             Receive response times: 10
    Min/Max/Average round trip time: 4/4/4
    Square-Sum of round trip time: 160
    Last succeeded probe time: 2026-07-30 15:36:31
  Extended results:
    Packet loss ratio: 0%
    Failures due to timeout: 0
    Failures due to internal error: 0
    Failures due to other errors: 0
```

ICMPエコー操作の履歴レコードを表示します。

```
[DeviceA] display nqa history admin test1
NQA entry (admin admin, tag test1) history records:
Index      Response     Status           Time
1993       4            Succeeded        2026-07-30 15:36:31
1992       4            Succeeded        2026-07-30 15:36:28
1991       4            Succeeded        2026-07-30 15:36:27
1990       4            Succeeded        2026-07-30 15:36:26
1989       4            Succeeded        2026-07-30 15:36:23
1988       4            Succeeded        2026-07-30 15:36:22
1987       4            Succeeded        2026-07-30 15:36:21
1986       4            Succeeded        2026-07-30 15:36:18
1985       4            Succeeded        2026-07-30 15:36:17
1984       4            Succeeded        2026-07-30 15:36:16
```

この出力から、デバイス A から送信されたパケットがデバイス C を介してデバイス B に到達できることがわかります。動作中にパケットロスは発生していません。最小、最大、および平均の往復時間は、それぞれ 4、4、4 ミリ秒です。

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

8. 高可用性

本マニュアルは以下に示す章で構成されています。

01-Track

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1章 Track の設定

> 🕮 メモ：
> Track 機能は。Version1.1.18 を含む以降のソフトウェアからサポートしています。

1.1. 概要

Track モジュールは、アプリケーションモジュールと検出モジュールの間で機能します。これにより、検出モジュール間の差異を意識することなく、アプリケーションモジュールを使用できます。

Track モジュールを検出モジュールおよびアプリケーションモジュールに関連付けることで、各モジュールが連携し、次のように動作します。

1. 検出モジュールは、ネットワークの到達可能性やネットワークパフォーマンスなどの特定のオブジェクトを監視し、検出結果を Track モジュールに通知します。
2. Track モジュールは、その検出結果をアプリケーションモジュールに送信します。
3. 追跡対象オブジェクトの変更が通知されると、アプリケーションモジュールはそれに対応し、通信の中断やネットワークパフォーマンスの低下を防ぐことができます。

1.1.1. 連携の基本

Track モジュールは、検出モジュールおよびアプリケーションモジュールと連携します。

I. Track モジュールと検出モジュール間の連携

検出モジュールは、追跡対象の検出結果を Track モジュールに送信します。Track モジュールは、追跡エントリの状態を次のように変更します。

- 追跡対象が正常に動作している場合、追跡エントリの状態は「Positive」となります。たとえば、以下のいずれかの条件を満たす場合、追跡エントリの状態は「Positive」となります。
  - ターゲットネットワークに到達可能である場合。
- 追跡対象が正常に動作していない場合、追跡エントリの状態は「Negative」となります。たとえば、以下のいずれかの条件に該当する場合、追跡エントリの状態は「Negative」となります：
  - ターゲットネットワークに到達できない場合。
- 検出結果が無効な場合、追跡エントリの状態は「NotReady」となります。たとえば、関連する NQA 操作が存在しない場合、追跡エントリの状態は「NotReady」となります。

Track モジュールには、以下の検出モジュールを関連付けることができます。

- NQA。

II. Track モジュールとアプリケーションモジュールとの連携

Track モジュールには、以下のアプリケーションモジュールを関連付けることができます。

- PoE。

1.2. トラック構成のタスクリスト

連携機能を設定するには、Track モジュールと検出モジュール間、および Track モジュールとアプリケーションモジュール間の関連付けを設定します。

Track モジュールを設定するには、以下のタスクを実行します。

タスクの概要
(必須) Trackモジュールと検出モジュールの関連付け • TrackとNQAの関連付け
(必須) Trackモジュールとアプリケーションモジュールの関連付け • TrackとPoEの関連付け • TrackとNetMeisterの連携

1.3. Trackモジュールと検出モジュールの関連付け

1.3.1. Track と NQA の連携

NQA は、ネットワークのパフォーマンスやサービス品質を分析するために、複数の操作タイプをサポートしています。たとえば、NQA 操作では、宛先に到達可能かどうかを定期的に検出できます。

NQA 操作は、Track エントリと関連付けられている場合、次のように動作します。

· 連続した失敗が指定された閾値に達した場合、NQA モジュールは、追跡対象に不具合が発生したことを Track モジュールに通知します。その後、Track モジュールは追跡エントリを「Negative」状態に設定します。

· 指定された閾値に達しなかった場合、NQA モジュールは、追跡対象が正常に動作していることを Track モジュールに通知します。その後、Track モジュールは追跡エントリを「Positive」状態に設定します。

NQA の詳細については、「システム管理」を参照してください。

Track を NQA に関連付けるには、次の手順を実行します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. トラックエントリを作成し、それを NQA 反応エントリに関連付ける	**track** *track-entry-number* **nqa entry** *admin-name operation-tag* **reaction** *item-number*	デフォルトでは、トラックエントリは存在しません。 指定された NQA 操作、またはトラックエントリ内の反応エントリが存在しない場合、トラックエントリのステータスは *NotReady* となります。

1.4. Trackモジュールとアプリケーションモジュールの関連付け

Track モジュールをアプリケーションモジュールに関連付ける前に、関連付けるトラックエントリが作成されていることを確認してください。

1.4.1. Track と PoE の関連付け

Track を PoE に関連付けるには、次の手順を実行します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. レイヤ 2 Ethernet interface view または、レイヤ 2 aggregate interface view に移行する	**interface interface-type interface-number**	―
3. PoE をインタフェース上のトラックエントリと関連付け、PD への到達可能性を確認する	**poe track** *track-entry-number* **action {alarm | alarm-reboot-pd}**	デフォルトでは、トラックエントリは PoE に関連付けられていません。

1.4.2. Track と NetMeister の関連付け

Track を NetMeister に関連付けるには、次の手順を実行します。

操作	コマンド	補足
1. system view に移行する	**system-view**	―
2. NetMeister をトラックエントリと関連付け、関連付けたトラックエントリのステータス変更を NetMeister クラウドプラットフォームにアップロードできるようにする	**netmeister track** *track-entry-number*	デフォルトでは、トラックエントリは NetMeister と関連付けられていません。

1.5. トラックエントリの表示と管理

表示コマンドは、どのビューからでも実行できます。

タスク	コマンド
トラックエントリに関する情報を表示します。	**displa track {** *track-entry-number* **| all [negative | positive]} [brief]**

QX-S900M シリーズ Ethernet PoE スイッチ

オペレーションマニュアル

9. 謝辞

本マニュアルは以下に示す章で構成されています。

01-謝辞

目次

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1章 謝辞（Acknowledgments） **1-1**

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 *
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 * by Eric Young (eay@cryptsoft.com).
 * The implementation was written so as to conform with Netscapes SSL.
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/* zlib.h -- interface of the 'zlib' general purpose compression library
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*/

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